

to penetrate a minimum of 30 feet into 20 plus blow count material (Standard Penetration Test). The borings were to provide subsurface data relative to positioning and preliminary design of structures along the proposed alignment.

Proposed borings 41 and 42 shown on Fig. 24 were not drilled during this investigation due to the refusal of the landowners to permit entry on the property. We recommend that after the State has acquired the property, the borings be accomplished to aid in the design of the roadway.

A summary of the location, depth and elevation of all borings drilled during this field exploration program is shown in Table 1.

B. Sampling

Representative soil samples were obtained in all borings at 5-foot depth intervals or where possible at major changes in material type.

In areas or at depths where predominantly granular soils were encountered, samples were obtained using the Standard Penetration Test method. This test utilizes a 2-inch O.D. split-spoon sampler. The sampler is driven into the soil with a 140-pound hammer free falling 30 inches. The number of blows required to drive the sampler 1-foot (penetration resistance) is used as an indication of the relative density of the soil. These samples were each field classified, sealed in glass jars and labeled for transmittal to the State Materials Laboratory, Olympia, Washington.

Where soft, cohesive materials were encountered, undisturbed sampling was attempted by hydraulically pushing a State sampler with 1-7/8-inch brass liners into the soil. A steady, continuous push was employed so as to obtain the least amount of disturbance. The brass liners removed from the sampler which contained undisturbed samples were field classified, marked, capped with brass or plastic caps and then sealed with electrician's tape and wax.

Ten undisturbed samples were obtained using 3-inch O.D. thin-walled Shelby tubes in four borings (150, 151, 152 and 154) located from approximately Stations L^L 942 to L^L 962. Previous borings in this section encountered gray, hard, clayey SILT similar to that encountered along the Seattle Freeway. Since this section is scheduled for extensive cutting, State Highway personnel requested additional borings be drilled and oriented samples obtained to attempt to determine the strike and dip of the bedding structure for consideration in the design of cut slopes. The tubes were first oriented with respect to a predetermined direction and then hydraulically pushed into the soil. After pushing the sample tube, the drive rods (A-rods) were marked. By maintaining the marked rods in their original position, the tube sample was brought to the surface. Using this method to control the position of the tube sample during extraction, the tube could then be marked accordingly to its in-situ orientation. This orientation was carefully preserved during the field inspection and transport of the sample to the State Materials Laboratory. Due to the field limitations of this orientation procedure, some tolerance must be allowed with respect to the precision of orientation. Generally, it can be assumed that the oriented samples are within ± 15 degrees of their actual direction of orientation. It is our opinion that this degree of accuracy is sufficient to give a reasonable approximation of strike and dip of bedding structure or laminations existing at the subsurface position represented by the sample.

Bag samples representing typical subgrade soils for R-value determinations were obtained at the following locations:

<u>Approximate Stationing</u>		<u>Offset</u>
L ^L	957 + 00	25 feet Left
L	1020 + 20	300 feet Left
L	1169 + 00	400 feet Right
L	1171 + 20	260 feet Right

TABLE I
SUMMARY OF TEST BORINGS

Boring Number	Station	Offset	Depth (Ft.)	Elevation of Observation well or Piezo-meter tip (Ft.)	Surface Elevation (Ft.)	Boring Number	Station	Offset	Depth (Ft.)	Elevation of Observation well or Piezo-meter tip (Ft.)	Surface Elevation (Ft.)	Boring Number	Station	Offset	Depth (Ft.)	Elevation of Observation well or Piezo-meter tip (Ft.)	Surface Elevation (Ft.)
1	L 892 + 65	None	34.0	---	22.4	50	L 1001 + 42	132' left	14.0	87.2	101.2	102	DD 13 + 00	None	13.0	---	382.0
2	L 897 + 02	15' left	24.0	---	25.5	51	L 1002 + 00	None	19.0	77.6	96.6	103	L 1133 + 00	None	34.0	336.0	370.0
3	N 195th 97 + 17	None	24.0	---	25.2	52	L 1004 + 50	None	19.0	---	100.1	104	DD 16 + 98	None	13.5	---	378.9
4	REL NE 195 12 + 37	10' left	29.0	---	34.0	53	L 1005 + 66	None	19.0	---	100.6	105	L 1134 + 14	156' right	20.5	348.1 *	368.1
5	REL 195th 7 + 62	10' right	29.0	---	43.2	54	L 1012 + 60	None	39.0	101.8	140.8	106	L 1135 + 50	None	19.0	350.0	369.0
6	REL Beardsley					55	AL ⁴ 16 + 00	None	19.0	102.4	121.4	107	L 1135 + 36	158' right	50.5	319.2 *	369.7
	Blvd. 42 + 87	82' right	27.8	---	40.2	56	L 1017 + 25	None	19.0	99.1	118.1	108	L 1136 + 62	158' right	26.0	344.1 *	370.1
6A	REL Beardsley					57	AR ⁴ 17 + 15	10' right	23.5	---	112.1	109	DM 7 + 23	15' left	19.0	---	403.3
	Blvd. 43 + 11	19' left	24.0	---	44.1	58	S.S.H. 2-J 664 + 22	50' right	34.0	---	151.5	110	L 1138 + 15	37' right	28.9	---	376.2
7	REL 195th 4 + 12	60' left	18.0	---	78.5	59	DL ⁴ 18 + 85	80' right	24.0	---	147.3	111	DM 12 + 38	8' right	28.0	---	392.3
8	120th Ave N. E. 901 + 73	12' left	24.0	14.8	38.6	60	L 1021 + 50	25' left	39.0	106.0	145.0	112	L 1142 + 49	30' left	18.5	---	424.1
9	N. E. 195th St. 20 + 00	23' left	31.5	21.5	31.5	61	AR ⁴ 21 + 47	None	14.0	---	114.5	113	DB 1 + 10	5' right	23.0	406.9	426.9
10	120th Ave N. E. 901 + 73	6' left	59.0	---	28.7	62	DL ⁴ 23 + 56	None	24.0	130.7	154.7	114	DB 4 + 06	None	18.5	---	440.0
11	120th Ave N. E. 901 + 73	7' left	19.0	29.8	44.2	63	DR ⁴ 24 + 93	None	19.0	---	145.8	115	DB 8 + 00	None	18.0	---	436.9
12	39th Ave N. E. 70 + 73	20' right	14.0	---	95.8	64	L 1031 + 00	None	28.5	125.8	154.3	116	DB 11 + 28	None	11.5	---	428.0
13	S-195th 94 + 00	25' left	19.0	---	52.1	65	L 1039 + 30	None	24.0	160.5	183.5	117	L 1148 + 95	82' right	27.6	---	449.1
14	195th N 3 + 30	25' right	19.0	---	37.7	66	L ^R 1042 + 00	46' right	18.5	---	188.1	118	BL 1 + 92	10' right	13.5	---	453.8
15	L 307 + 90	None	19.0	---	50.0	67	L ^L 1043 + 81	5' right	14.0	---	196.9	119	L 1151 + 99	3' left	28.0	427.4	454.4
16	L 913 + 85	5' right	24.0	35.4	59.4	68	L ^R 1049 + 30	5' left	19.0	---	199.9	120	BL 5 + 50	None	14.0	---	458.0
17	L 917 + 47	77' left	18.5	---	68.5	69	L ^L 1052 + 22	58' left	43.5	---	228.6	121	L 1156 + 18	None	48.5	410.3	458.8
18	L ^W 924 + 45	25' left	24.0	---	64.3	70	L ^R 1057 + 00	None	18.3	---	218.2	122	L 1161 + 90	20' right	58.4	---	457.1
19	L ^R 929 + 60	None	13.0	---	67.2	71	L ^L 1061 + 00	140' left	53.0	253.7	298.7	123	L 1166 + 00	80" right	53.0	389.6	437.6
20	L ^L 935 + 08	16' right	24.0	---	86.6	72	L ^R 1067 + 60	15' right	28.5	---	262.5	124	L 1169 + 00	150' left	36.5	---	435.6
21	L ^R 938 + 00	None	29.0	51.8	80.8	73	L ^L 1068 + 73	139' left	58.5	270.2	328.7	125	L 1172 + 00	100' right	28.5	---	324.6
22	L ^L 938 + 74	30' left	29.0	---	123.7	74	L ^R 1073 + 20	40' left	24.0	---	282.7	126	L 1172 + 00	90' left	34.0	287.3	317.3
23	L ^R 943 + 00	None	29.0	61.9	90.9	75	L ^L 1075 + 22	None	24.0	258.8	282.8	127	FB 88 + 55	30' right	19.0	---	318.6
24	L ^L 944 + 32	100' left	74.0	105.0	179.0	76	L ^R 1078 + 50	None	21.5	---	275.0	128	L 1173 + 00	5' right	44.0	---	309.5
25	L ^R 946 + 00	9' right	24.0	91.6	115.6	77	L ^L 1083 + 00	None	14.0	---	305.3	129	FB 82 + 86	48' right	14.0	---	307.8
26	L ^L 949 + 00	100' left	78.0	120.0	198.0	78	L ^R 1086 + 23	None	14.0	280.3	294.3	130	L 1176 + 00	None	44.0	280.2	309.5
27	L ^R 950 + 00	None	28.0	---	143.7	79	L ^L 1087 + 70	None	24.0	---	305.5	131	FB 87 + 46	50' left	19.0	---	314.2
28	L ^L 952 + 00	30' left	63.5	---	225.6	80	RN 0 + 18	None	23.5	---	431.0	132	FM 3 + 85	64' left	29.0	---	328.4
29	L ^R 954 + 00	17' left	29.0	112.9	141.9	81	RN 4 + 60	None	24.0	---	395.0	133	FM 4 + 58	76' right	24.0	304.9	314.9
30	L ^L 957 + 00	100' left	94.0	205.6	230.6	82	RN 7 + 68	8' right	9.0	---	341.7	134	L 1180 + 07	146' right	24.0	303.4	313.4
31	L ^R 957 + 84	58' left	33.8	143.9	166.9	83	RN 12 + 20	None	9.0	---	328.0	135	L ^R 1182 + 47	None	24.0	---	321.0
32	L ^L 963 + 00	7' left	69.0	(1) 133.8 (2) 187.8	202.8	84	RN 15 + 82	None	19.0	---	312.0	136	FM 6 + 69	25' right	9.0	---	316.2
						85	RN 19 + 80	5' left	14.0	---	321.5	137	L ^L 1184 + 20	107' left	19.0	---	317.8
33	L ^R 965 + 92	55' left	24.0	---	166.2	86	RN 26 + 48	None	14.0	---	368.8	138	FM 9 + 16	34' left	14.0	---	319.2
34	L ^L 970 + 40	70' left	19.0	170.9	189.9	87	RN 31 + 00	None	12.8	---	406.9	139	L ^L 1184 + 94	23' right	24.0	304.7	319.7
35	L ^R 971 + 23	50' right	19.0	---	165.2	88	RN 35 + 95	40' left	14.0	---	433.5	140	L ^R 1189 + 70	None	23.5	---	356.6
36	L ^L 975 + 00	60' left	49.0	---	199.1	89	L ^L 1097 + 50	87' left	19.0	---	362.3	141	L ^L 1190 + 63	15' right	24.0	---	357.8
37	L ^R 979 + 02	70' right	39.0	141.2	180.2	90	L ^R 1098 + 23	110' left	27.6	---	360.3	142	L ^R 1193 + 55	None	19.0	---	363.4
38	L 987 + 00	None	32.0	83.0	115.0	91	L ^L 1109 + 82	None	54.0	---	405.4	143	L ^L 1193 + 02	37' left	24.0	332.2	352.2
39	HJ ² 22 + 47	10' left	13.5	---	247.7	92	L ^R 1111 + 00	None	29.0	---	380.0	144	L ^L 1193 + 66	33' right	16.5	334.5 *	351.0
40	HJ ² 16 + 89	None	9.0	---	244.1	93	L ^L 1113 + 52	110' right	34.0	---	374.3	145	L ^R 1195 + 50	15' left	11.5	341.6	353.1
43	HJ ² 29 + 48	52' west				94	L ^L 1114 + 86	100' left	24.0	---	423.0	146	L 997 + 70	45' right	39.0	58.8	97.8
		56' south	9.0	---	231.5	95	L ^R 1119 + 70	36' left	19.0	---	390.7	147	L 1001 + 20	45' left	39.0	66.9	95.9
44	L 991 + 80	95' right	24.0	87.9	111.9	96	L ^L 1120 + 80	80' left	24.0	---	408.2	148	SSH 2-J 660 + 47	35' right	58.0	---	145.7
45	L 994 + 00	9' left	17.8	---	129.8	97	DD 4 + 37	40' right	19.0	---	401.6	149	SSH 2-J 655 + 87	17' right	49.0	96.4	145.4
46	L 998 + 10	30' left	24.0	---	98.4	98	DD 5 + 82	20' right	14.0	---	385.3	150	L ^L 957 + 00	25' left	37.8	177.7	215.5
47	CA 01 + 26	None	19.0	---	95.7	99	L ^L 1124 + 72	42' right	24.0	361.8	384.8	151	L ^L 952 + 00	100' left	77.8	160.7	238.5
48	L 999 + 30	20' left	18.0	---	96.7	100	L ^L 1126 + 65	None	18.5	---	384.2	152	L ^L 949 + 00	35' left	58.3	145.5	203.5
49	19th Ave. E 2 + 22	18' right	14.0	---	106.9	101	L 1129 + 25	None	17.8	---	386.6	153	L 890 + 40	70' left	64.0	-41.2	21.8
												154	L ^L 961 + 50	50' left	33.0	191.6	224.6

* Piezometer

The locations are shown on Figs. 9, 17, and 18. The generalized soil types and the approximate limits of the soil types are shown on Fig. 33.

C. Observation Wells and Piezometers

Since groundwater conditions affect the stability of slopes cut into hillsides and construction procedures, observation wells were installed in the borings at selected intervals along the proposed route. They consist of a 6-inch porous tip connected to a 1/2-inch diameter plastic riser pipe. The tip is generally positioned at the bottom of the boring or at some other predetermined depth in the borings. A relatively clean sand was backfilled around each tip up to an elevation to include any possible drainage strata. The observation wells were sealed at the ground surface with 2 to 3 feet of impervious material from the boring or a mixture of bentonite and local material. Piezometers were sealed with a 2 to 3-foot thick mixture of bentonite and pea gravel at a predetermined elevation to prevent surface water or water from a higher elevation from entering. The water level in each observation well and piezometer was observed at selected intervals of time during the field explorations. Upon completion of the field explorations, the readings of the observation wells and piezometers were turned over to State employees.

In addition to the observation wells installed in the selected sampled borings, two additional observation wells were installed in borings at the Canyon Park Junior High School and two on the property of Bothell Farms, Incorporated to monitor groundwater levels during cutting and filling operations in these areas.

The locations of all observation wells and piezometers installed in borings within the highway right-of-way are also listed in Table 1 and are shown on the Plan and Soil Profile, Figs. 2 through 30. The locations of the observation wells at the Canyon Park Junior High School and on the property of Bothell Farms, Incorporated, which are outside the right-of-way, are shown on Fig. 31.

D. Probings

The proposed culvert locations were examined and probed with a 3-foot long by 3/8-inch diameter bar to determine the presence of any soft areas at these locations. At locations where the probe could be pushed 2 feet with moderate effort, additional probings were performed at 20-foot intervals along the longitudinal axis of the proposed culverts. Additional probings were performed at the following locations:

<u>Approximate Stationing</u>	<u>Fig No.</u>
L ^L 933 + 70	4
L 987 + 25	8
L 990 + 20	8
L 999 + 45	8
L 1001 + 10	8
L 1006 + 10	8
L 1008 + 35	8
L 1017 + 10	9
L 1030 + 00	9
L ^R 1050 + 50	11
L ^L 1073 + 70	10
L ^R 1080 + 10	13
L ^R 1085 + 10	13
L ^L 1085 + 45	12
L 1133 + 45	15
AL ⁴ 17 + 00	27
AR ⁴ 18 + 30	27

The depths of probing shown on the figures represent the maximum depths that could be probed along the longitudinal axis of the culvert. Probings less than 24 inches are not shown. Probings less than 24 inches have not been shown since it is assumed that about 2 feet of material will be removed at each culvert location (1-foot of topsoil plus 1-foot for bedding material).

Hand probings were also accomplished to delineate soft areas along the proposed route. The lateral extent of soft areas as determined by probing is shown on Plan and Soil Profile, Figs. 2, 8, 9, 15, 16, 17, 21 and 22.

III. GEOLOGY AND PHYSIOGRAPHY

The proposed highway alignment from North Creek to Swamp Creek is situated on a portion of the Puget Lowland, a feature which extends from east of Puget Sound to the west flank of the Cascade Mountains. The Lowland is typified by north-south trending drumoidal ridges. Major drainage parallels these ridges while tributaries are generally normal to the ridges, producing east-west ravines on the flanks. The highway alignment ascends the slope from Sammamish Slough east of the city of Bothell, crosses a succession of ridges in a northwesterly direction, and then descends abruptly into the valley of Swamp Creek near Alderwood Manor.

This area is a product of a series of glacial advances and recessions and is characteristically underlain by glacial tills, outwash deposits, and occasional lacustrine clays and silts. The major valleys, such as North Creek Valley, contain thick, post-glacial deposits of alluvial silt, sand and peat. The low areas between ridges contain recessional outwash and relatively thin peat beds. In general, the uplands are blanketed with a variable thickness of glacial till underlain by pro-glacial sand, gravel, clay and silt.

The following paragraphs discuss geologic conditions which exist along the alignment.

From about Stations 890 to 920, the highway crosses a northern extension of Sammamish Slough which, in addition to the alluvial sands and silts, contains relatively thick peat deposits. Along the western edge of the Slough, very dense glacial till was encountered below the recent alluvial sands.

The alignment between Stations 920 and 980 crosses the northeastern flank of a ridge known as Beckstrom Hill. This hill consists mainly of very silty, outwash sands and lacustrine clayey silts overlying coarser sands and gravels, all of which have been glacially overridden. Recent alluvium from the North Creek Valley extends partially up the eastern slope of this hill and is underlain by glacial till.

An inter-ridge area which roughly parallels the Bothell-Everett Highway (SSH-2J) exists from about Stations 980 to 1035. This area contains recessional outwash (medium-dense sand and silt) deposited during the last glacial retreat. In the topographic lows of this inter-ridge area, swampy conditions exist and thin surficial deposits of peat have accumulated over the medium dense sands. Glacial till occurs along the edges of the area and may also underlie the recessional outwash sands.

From Stations 1035 to 1169, the alignment crosses the northeastern flank of another north-south trending ridge which rises to a maximum elevation of approximately 460 feet. Glacial till from 10 to 30 feet thick forms an imperfect blanket over the ridge and overlies earlier deposits of very dense outwash sands. These sands are, in turn, underlain by as much as 10 feet of hard, laminated silt. Excellent exposures of the sand-till contact are present in gravel pits along Filbert Road near Station 1169.

At Station 1169, the grade descends into the Swamp Creek Valley. From this point to Station 1196, the alignment crosses outwash sands and gravels similar to those exposed in the previously mentioned gravel pits.

IV. CLIMATOLOGY

Data supplied by the U. S. Weather Bureau for the Bothell Station, indicate the following climatological conditions prevail along the alignment of the proposed highway. The mean annual temperature is about 50° F. A mean maximum temperature of about 75° F occurs in July and August and a mean minimum temperature of about 30 to 32° F occurs in January and February.

The average annual precipitation is approximately 40 inches with the largest amount of precipitation occurring in December and January when from 5 to 6 inches fall during each of the two months. Snowfall generally occurs in January and averages about 6.5 inches for that month. The depth of annual frost penetration varies, but during an average winter, a maximum of from 15 to 20 inches occurs, depending upon the amount of snow cover. The average number of frost-free days per year is 145, beginning May 13 and ending October 5.

V. SOIL TYPES AND DISTRIBUTION

A. General

The following paragraphs discuss in general the major soil types encountered during the field exploration program. The lateral extent of each material type is roughly delineated by stations, starting from Station L 890 near North Creek. Refer to the Plan and Soil Profiles, Figs. 2 through 30 for more detailed results and descriptions of subsurface materials.

B. Stations 890 to 898

The materials underlying this portion of the alignment consist of up to 20 feet of soft, fibrous PEAT and peaty SILT overlying a loose to medium, silty, fine SAND grading to a very dense, fine SAND.

A deposit of soft PEAT up to 50 feet thick was found to exist along the proposed frontage road between Stations 120th Ave. N.E. 33+00 and 120th Ave. N.E. 44+00. The peat was underlain by medium dense fine to medium SAND.

C. Stations 898 to 936

This portion of the alignment is underlain by up to 15 feet of very loose to medium dense, silty fine SAND interbedded with clayey to sandy SILT overlying a medium dense, silty fine to coarse SAND with some gravel. From Stations 935 to 936 the above materials were found to be underlain by a hard clayey SILT.

D. Stations 936 to 957

Above about elevation 170 a stiff to hard, fine sandy clayey SILT was encountered. Since this material will be encountered in most of the cuts in this section, a great deal of caution must be exercised in designing the cut slopes in order to eliminate the possibility of landslides developing. Below about elevation 170 and underlying the silt exists a very dense, fine to coarse SAND with some gravel. Beneath this material, at about elevation 120 feet, a dense to very dense, slightly clayey, sandy SILT with a trace of gravel was encountered.

E. Stations 957 to 985

From about Station 957 the previously mentioned clayey SILT grades into a very dense, silty SAND with some gravel interbedded with thin (5 feet or less) hard clayey SILT layers. The materials encountered within this section are predominantly medium dense to dense, silty, fine to coarse SAND with some gravel and occasional thin slightly clayey SILT layers.

F. Stations 985 to 1020

This portion of the proposed alignment is located predominantly in a low swampy area with occasional higher areas. The swampy areas are characterized by the existence of approximately 7 feet of soft fibrous PEAT interbedded with soft, organic SILT overlying a medium dense to dense, gray, fine to coarse SAND. The topographic highs within this section consist predominantly of a medium dense to dense, silty, fine to coarse SAND with some gravel, this material correlating with the SAND and GRAVEL underlying the PEAT and SILT within the swampy area.

G. Stations 1020 to 1050

Within this portion of the alignment a medium dense, silty to fairly clean SAND with gravel was encountered which apparently overlies a dense sandy CLAY and SILT (TILL).

H. Stations 1050 to 1090

This segment of the proposed highway consists predominantly of medium to very dense silty gravelly SAND, occasionally capped with a very dense, silty SAND and GRAVEL mixture (TILL). The till layer does not appear to be continuous throughout this section of the proposed alignment.

I. Stations 1090 to 1120

This portion of the proposed alignment is capped by approximately 30 feet of glacial till consisting of a very dense mixture of SILT, SAND and GRAVEL overlying a very dense, silty SAND with some gravel.

J. Stations 1120 to 1130

The materials found to be underlying this section of the proposed alignment consist of a medium to very dense, silty SAND with some gravel. There is no apparent TILL cap within this section.

K. Stations 1130 to 1137

This portion of the proposed alignment crosses a swampy area which is underlain by about 7 feet of soft brown PEAT and organic SILT and CLAY. Underlying the PEAT and CLAY is a very dense, silty, fine to medium SAND and GRAVEL.

L. Stations 1137 to 1169

Approximately 30 feet of till consisting of very dense, silty, slightly clayey, gravelly SAND overlying a very dense, gray-brown, silty SAND and GRAVEL was found to exist within this portion of the proposed alignment.

M. Stations 1169 to 1196

The borings along this section of the proposed alignment encountered predominantly a medium dense to very dense, silty, fine to coarse SAND with some gravel. Underlying the SAND is a layer of hard, gray, silty CLAY and clayey SILT which in turn is underlain by very dense, silty SAND.

In the vicinity of borings 126 and 128 (Stations 1172 and 1173) a loose silty fine SAND approximately 5 feet thick was encountered overlying the dense silty SANDS. In two small ponds in the vicinity of borings 144 and 145 (Stations L^L 1194 and L^R 1195) approximately 4 feet of soft PEAT was encountered overlying a dense to very dense SAND and GRAVEL.

VI. GROUNDWATER

Groundwater found along the route between Stations 890 and 920 is relatively close to the surface and generally associated with a dark gray, fairly clean, fine to medium sand. The water table was encountered at an approximate depth of 11 feet near Station 901. This depth decreases until the water table intersects the ground surface near North Creek, approximately at Station 890. A water well (498 feet deep) drilled east of Station 920 in the 1940's is known to have flowed approximately 1 gpm at the time of drilling.

From Stations 920 to 980, perched water tables exist at various elevations causing numerous seeps along the hillside. The springs are the source of many small streams. The seepage zones are believed to be associated with slightly silty to clean sandy layers within thick, very silty sands and sandy silts.

Artesian water was encountered in gray, clean, outwash sands beneath a relatively impervious silty, gravelly sand (possible till) layer near Station 980. At present, water is flowing from the observation pipe installed in boring 38 at a rate of less than 1 gpm.

In the vicinity of Station 1020, the water table is within 10 to 15 feet of the surface. Where the ground surface is below an approximate elevation of 120 feet, water accumulates at the surface giving rise to swampy conditions.

Ponds commonly exist in local depressions where till occurs at the surface, such as between Station 1050 and Station 1169. Seepage zones also occur in thin sand and gravel layers within the till. Outwash sands below the till carry varying amounts of water. Near Station 1124, where outwash is

exposed at the surface, water table fluctuations are the apparent cause of intermittent ponding.

In the topographic high areas between Station 1150 and Station 1169, which will be affected by cuts for the Filbert Road overpass, water level readings indicate the water table to be present at approximate elevation 380 feet.

From Station 1169 to Station 1196, water occurs relatively close to the surface in outwash sand and gravel. In addition, some surface ponding of water exists in the vicinity of Station 1193.

VII. EMBANKMENTS

Fills along the alignment will range from a height of a few feet to a maximum height of about 70 feet for the approach fill at the Filbert Road overcrossing. Our investigations indicate that the greater percentage of the fills for the alignment will be placed on medium dense to very dense, sands and gravels and no unusual foundation problems are anticipated.

The fill locations which are underlain by peats and organic silts are listed below:

<u>Approximate Stationing</u>	<u>Approximate Maximum Depth of Soft Material</u>	<u>Approximate Maximum Height of Fill</u>
L 890 to L 898	25 feet	10 feet
L 986 to L 993	10 feet	40 feet
L 997 to L 999	2 feet	30 feet
L 1001 to L 1011	5 feet	25 feet
L 1016 to L 1019	10 feet	10 feet
L ^R 1073 + 50 to L ^R 1074 + 50	2 feet	15 feet
L ^R 1085 + 00 to L ^R 1085 + 30	2 feet	15 feet
L 1131 + 60 to L 1137 + 60	10 feet	35 feet
L ^L 1193 + 50 to L ^L 1194 + 00	5 feet	10 feet
L ^R 1195 + 00 to L ^R 1196 + 50	3 feet	5 feet
N.E. 195th St. 20+70 to N.E. 195th St. 23+70	10 feet	20 feet

<u>Approximate Stationing</u>	<u>Approximate Maximum Depth of Soft Material</u>	<u>Approximate Maximum Height of Fill</u>
N.E. 195th St. 29+75 to N.E. 195th St. 33+08	50 feet	2 feet
120th Ave. N.E. 33+08 to 120th Ave. N.E. 43+80	50 feet	4 feet
120th Ave. N.E. 51+30 to 120th Ave. N.E. 55+30	10 feet	7 feet

In our opinion and without the benefit of a detailed study, all of the peat existing at shallow depth (10 to 15 feet) should be removed in the embankment areas. In the one area at the beginning of this project (Stations 890 to 898) where the peat reaches a maximum depth of approximately 15 feet and which is underlain by about 10 feet of soft organic silt, the peat should be removed and the organic silt preloaded to reduce the settlements.

Where substantial depths of peat (50 feet) are found such as beneath the proposed Frontage Road (120th Ave. N.E.), approximately between Stations 33 + 00 and 55 + 00, a detailed study should be made of the feasibility of sand drains coupled with preloading or displacement. Placement of the planned embankment over this area without treatment of the peat will result in continual settlement and warping of the roadway requiring continued maintenance.

VIII. SLOPE STABILITY

The location of the major cuts to be made along the proposed alignment are listed below:

<u>Approximate Stationing</u>	<u>Maximum Depth of Cut</u>
L ^L 939 to L ^L 983	50 feet
L ^R 970 to L ^R 983	30 feet
L 1010 to L 1014	25 feet
L 1019 to L 1027	20 feet
L ^L 1054 to L ^L 1072	30 feet
L ^R 1061 to L ^R 1073	20 feet

<u>Approximate Stationing</u>	<u>Maximum Depth of Cut</u>
L ^L 1093 to L ^L 1122	25 feet
L ^R 1092 to L ^R 1120	20 feet
L 1142 to L 1170	55 feet
L ^L 1186 to L ^L 1195	25 feet
L ^R 1186 to L ^R 1195	20 feet

Results of the subsurface exploration program indicate that all cuts except from about Stations L^L 939 to 983 will be made in medium to very dense, silty sand and gravel or silty sand and gravel overlain by glacial till, consisting of very dense, very silty sand and gravel. Properly designed cuts in these materials are expected to be stable.

The cuts which are to be made from about Station L^L 939 to L^L 983 will encounter very stiff to hard, clayey silt and sandy silt similar in nature to the silts and clays which were encountered along the Seattle Freeway and in which numerous slope failures developed. Additional borings were drilled along this section in order to evaluate the occurrence and attitude of the silts and clays. Cross-sections of the proposed cuts in the silts and clays along with the boring are shown on Fig. 32. Due to the nature of these materials particular attention should be given to designing the cut slopes in this area.

Borings made in the vicinity of Stations L 1142 to L 1170 indicate that the cut will penetrate glacial till and encounter underlying silty sand and gravel all of which contain seepage zones as noted during the drilling operations. Special considerations should be given to the possibility that seepage from the till and underlying sands and gravels could cause erosion of the sands and gravels and possible resultant slumping of blocks of glacial till from above.

In locations where cuts will be in silty sands and where groundwater levels are above grade, provision should be made for controlling seepage from above the road grade to prevent erosion of the cut slope. This condition exists particularly in the cut to be made between Stations L^L 1054 and 1072 and from L^L 1186 and L^L 1195.

IX. MATERIALS

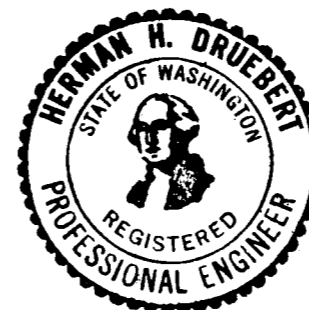
In general, all of the materials which will be encountered in the cuts can be utilized for granular fills. Although relatively clean sand and gravel exists locally, for the most part, the fills will consist of a silty sand and gravel mixture. It is expected that these materials will necessarily have to be placed during relatively dry periods since in all probability they will become "spongy" if placed during the wet season.

No solid bedrock was encountered during this investigation and none should be anticipated during construction of the highway. The glacial tills encountered are not expected to be unusually difficult to excavate.

The materials which exist at grade in cut sections and approximately 1-foot below the ground surface in fill sections are roughly delineated on Fig. 33. This figure is based upon our visual observations and review of the field logs and should be used only as a very approximate indication of what materials will be encountered at grade. Bag samples of each type, except the Peat have been shipped to the State of Washington Materials Laboratory.

X. INDEPENDENT REVIEW

An independent review by Allen S. Carey, Senior Geologist, assisted by John H. Hughes, Geologist, of Shannon & Wilson, Inc., was performed and their findings and comments incorporated in this report.

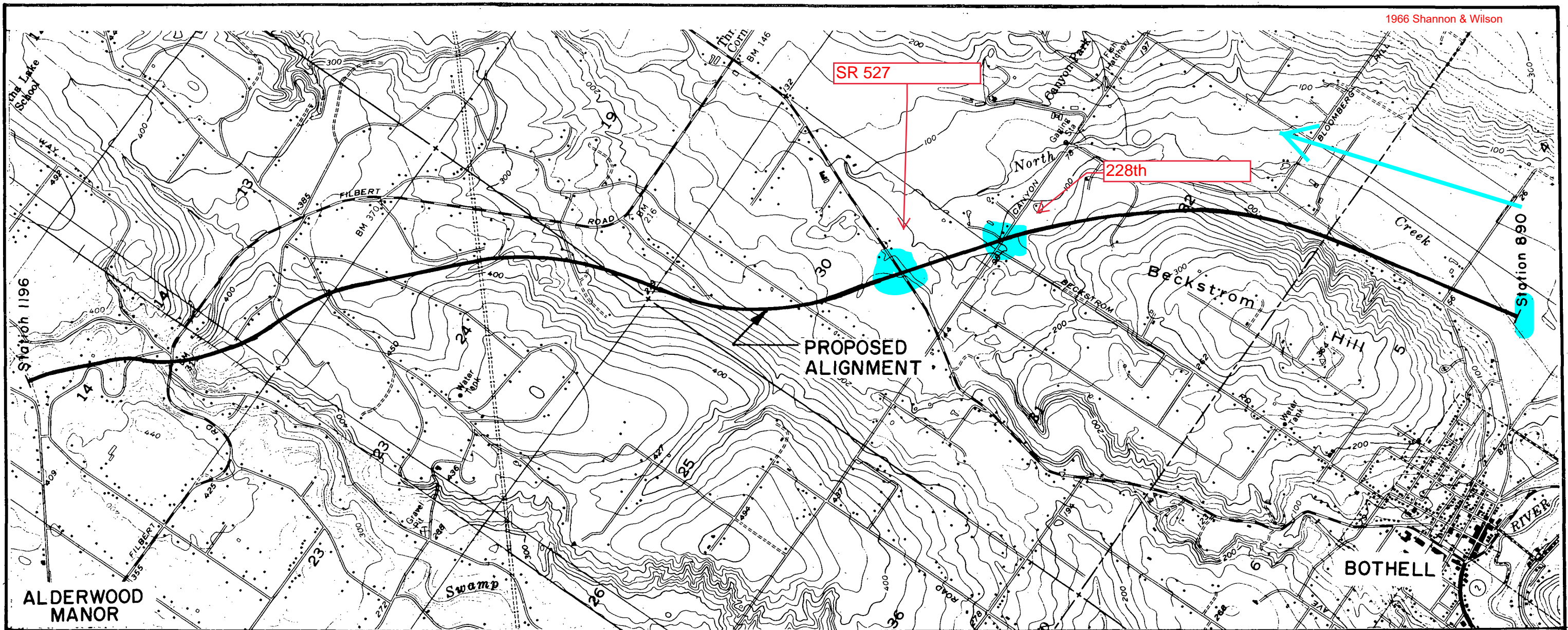


SHANNON & WILSON, INC.

Herman H. Druebert
Herman H. Druebert, P.E.



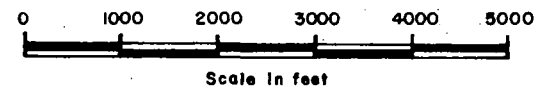
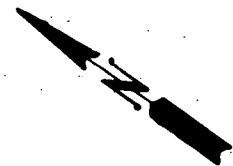
Earl A. Sibley
Earl A. Sibley, P.E.



ALDERWOOD MANOR

PROPOSED ALIGNMENT

BOTHELL



Base map modified from USGS Edmonds & Bothell quadrangles.

Contour interval 20 feet - Datum is Mean Sea Level

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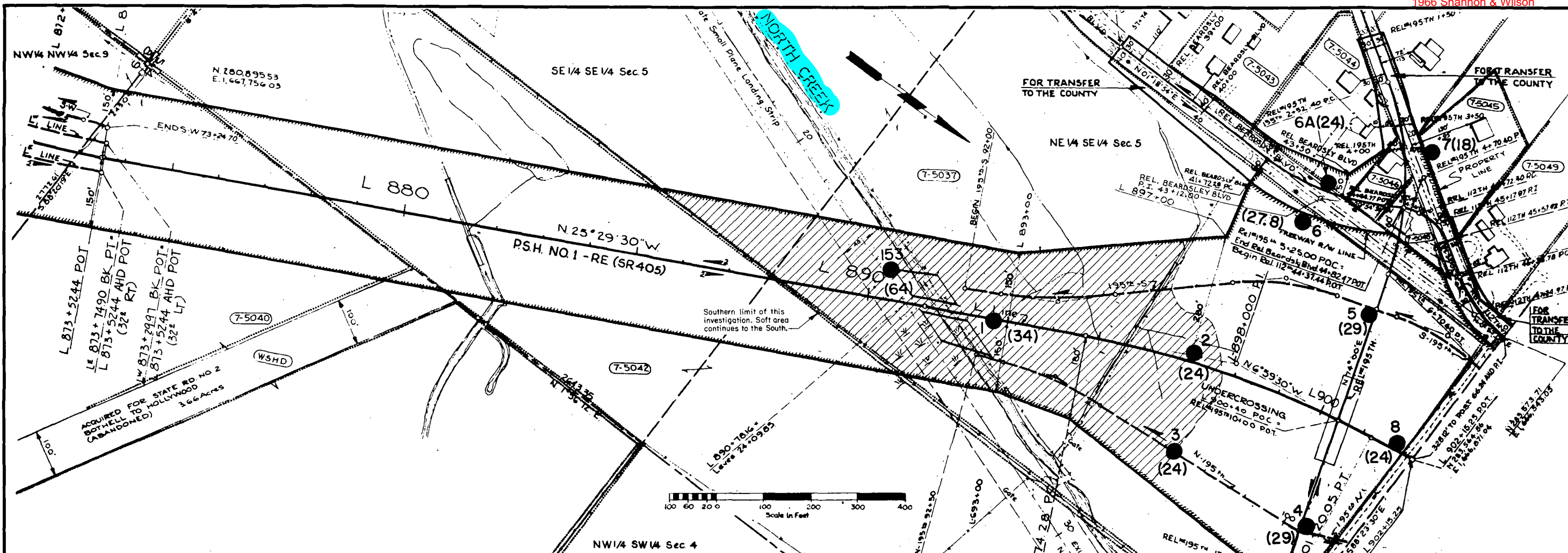
PSH I-RE (SR 405)
 PROPOSED ALIGNMENT
 STA. 890 TO 1196

AUGUST 1, 1966

W-66-965

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 SOIL MECHANICS & FOUNDATION ENGINEERS
 SEATTLE, WASHINGTON

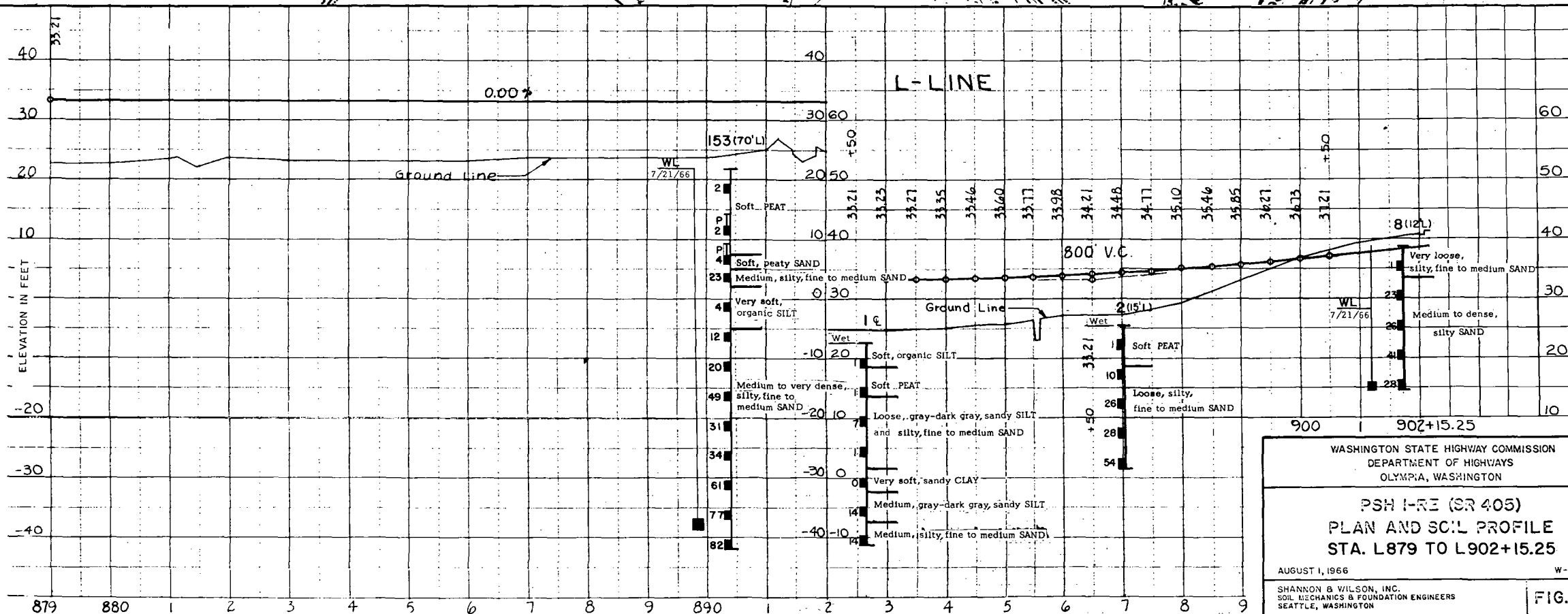
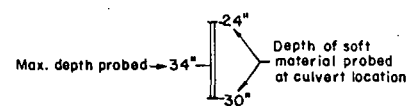
FIG. 1



NOTE:
Drawing based on plans and profiles supplied by Department of Highways.

LEGEND:

- 23 — Boring number
- — Boring location
- (73) — Depth in feet
- Boring number
- 29 (7'L) — Offset from centerline
- 66 — Standard Penetration Test sample—blows per foot on left
- WL — Water level
- PI — Pushed State Sampler sample
- Oriented 3" Shelby Tube sample
- ▨ — Piezometer seal
- — Observation well or piezometer tip
- ▨ — Approximate extent of soft area



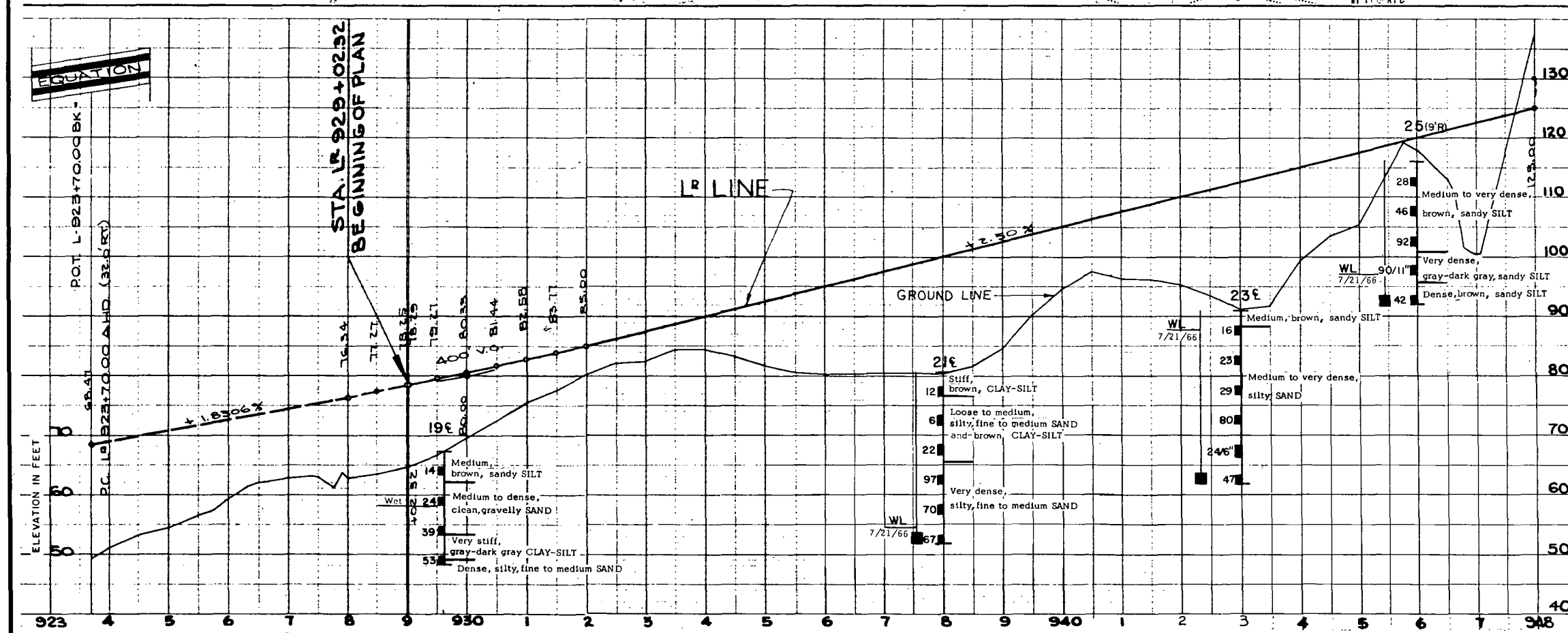
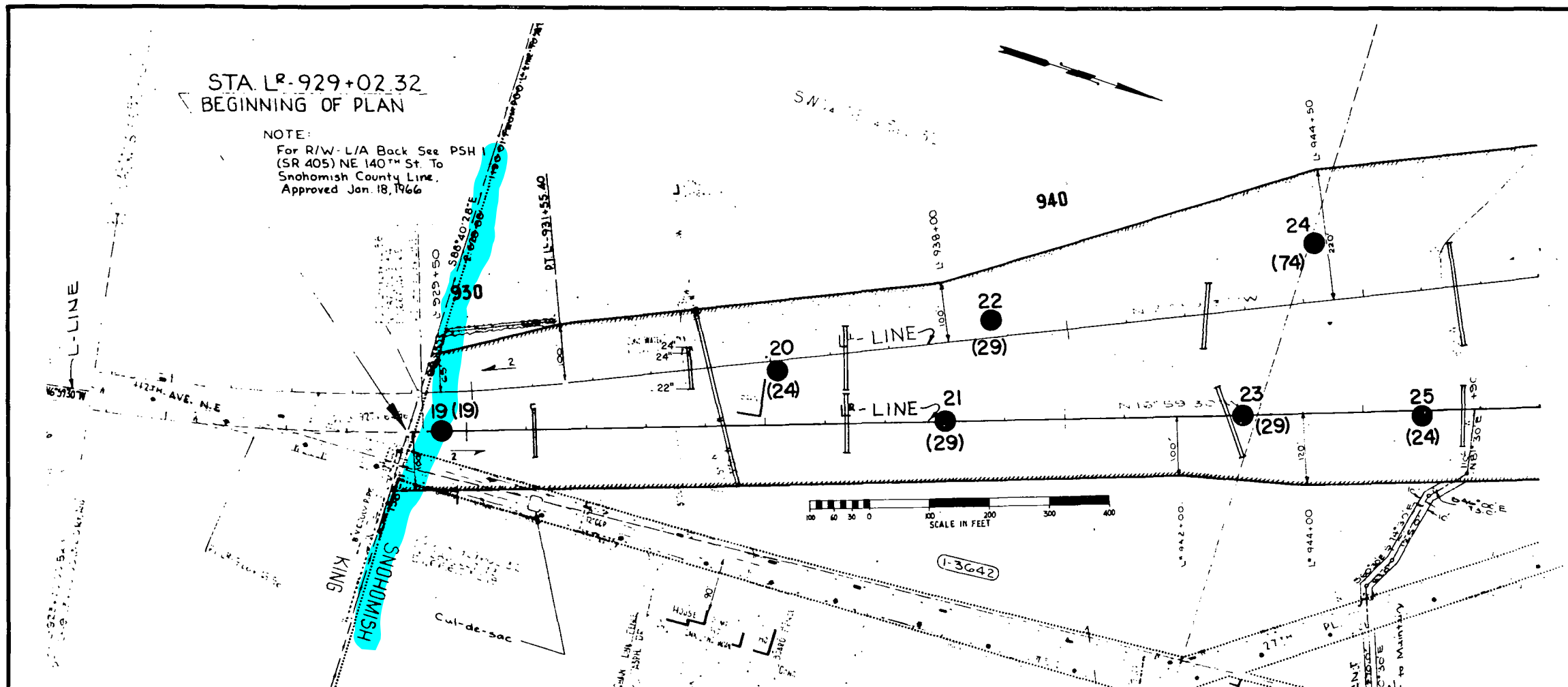
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PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L879 TO L902+15.25

AUGUST 1, 1966 W-66-965

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FIG. 2



NOTE:
Drawing based on plans and profiles
supplied by Department of Highways.

- LEGEND:
- 26 — Boring number
 - — Boring location
 - (78) — Depth in feet
 - Boring number
 - 29(17'L) — Offset from centerline
 - 66 — Standard Penetration Test sample—blows per foot on left
 - WL — Water level
 - P.I. — Pushed State Sampler sample
 - II — Oriented 3" Shelby Tube sample
 - — Piezometer seal
 - — Observation well or piezometer tip
 - ▨ — Approximate extent of soft area
- Max. depth probed — 34"
Depth of soft material probed at culvert location

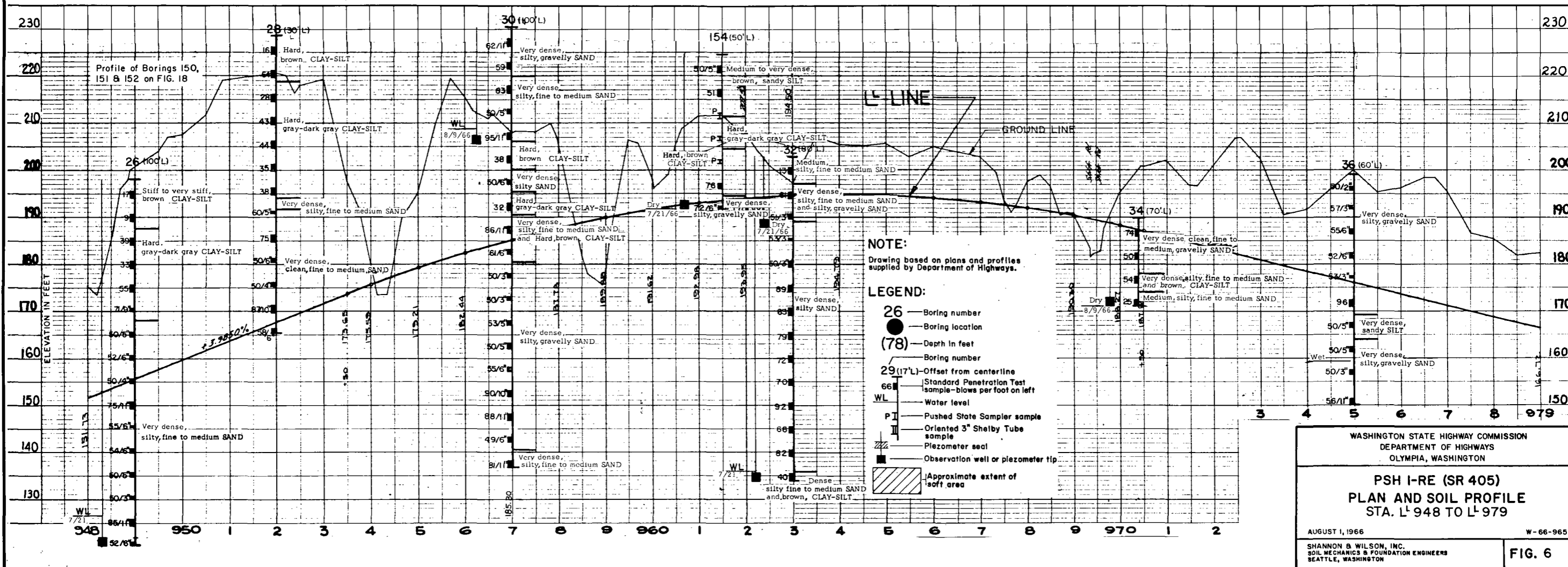
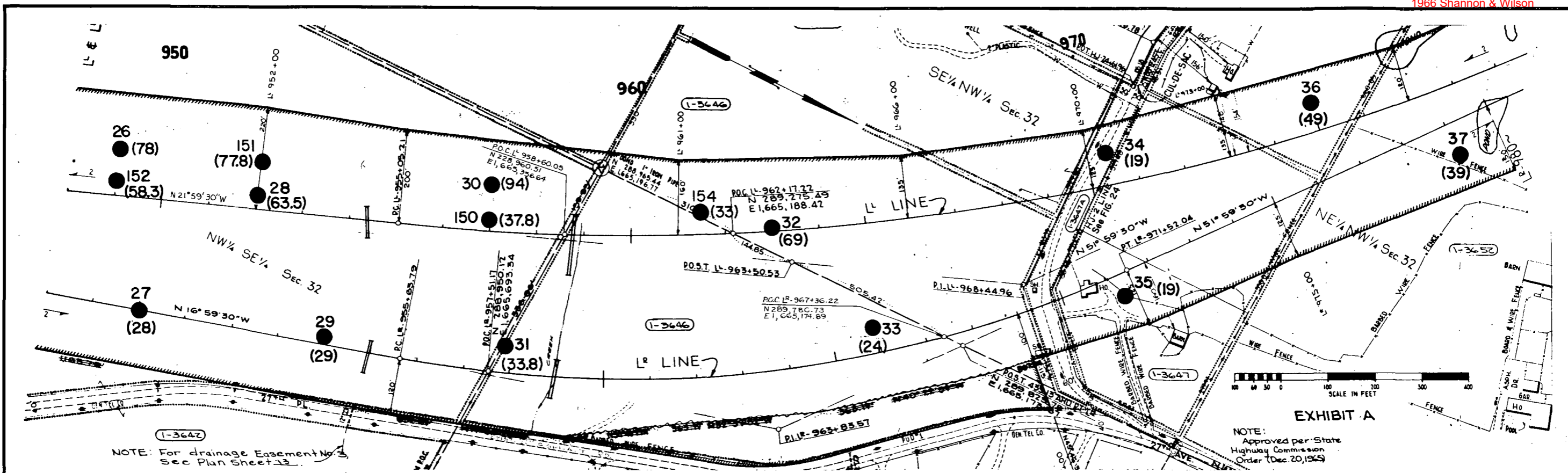
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PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L^R 923 TO L^R 948

AUGUST 1, 1966 W-66-965

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FIG. 5



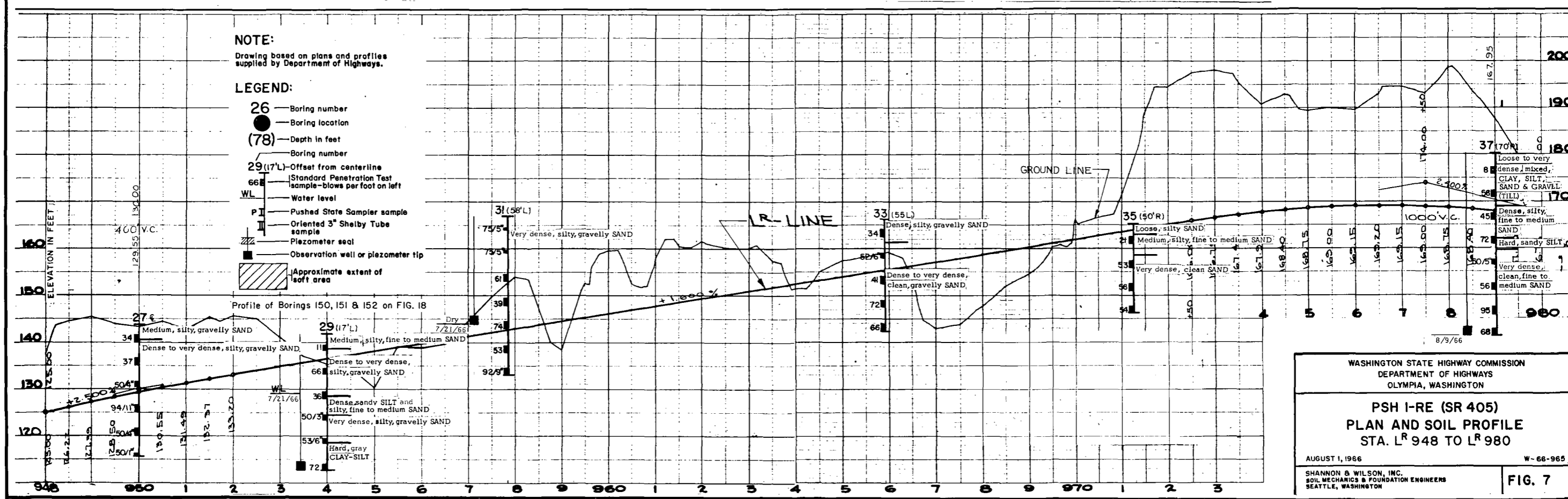
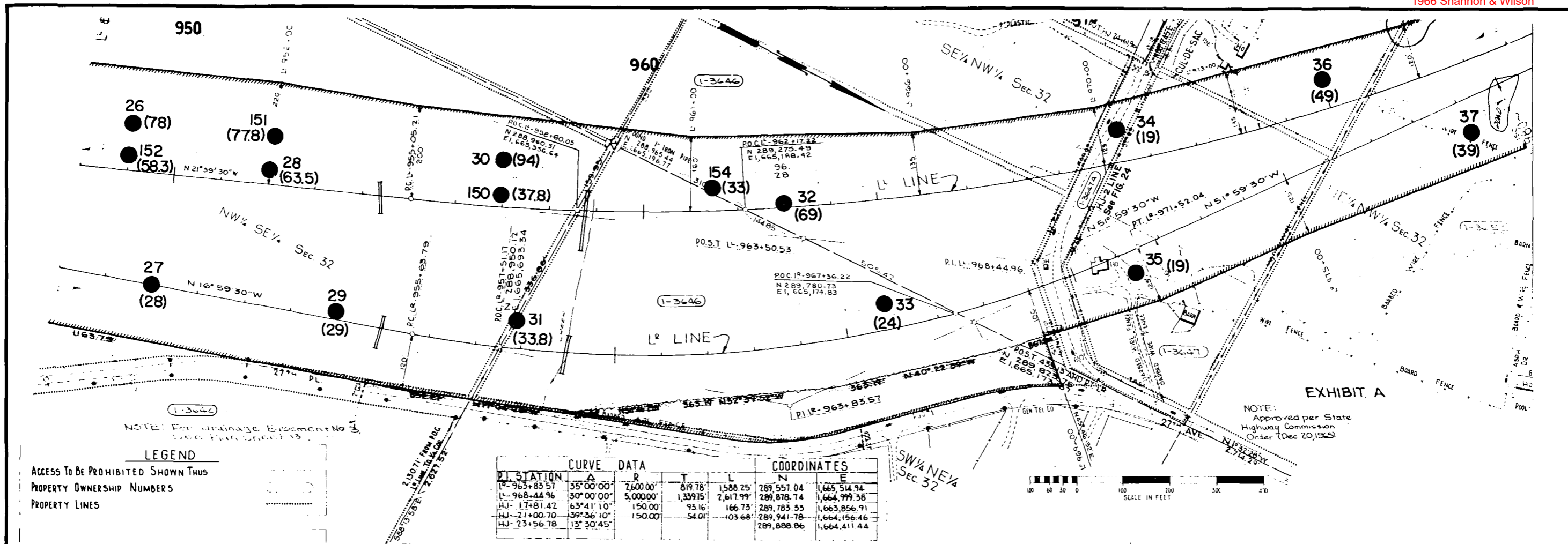
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DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

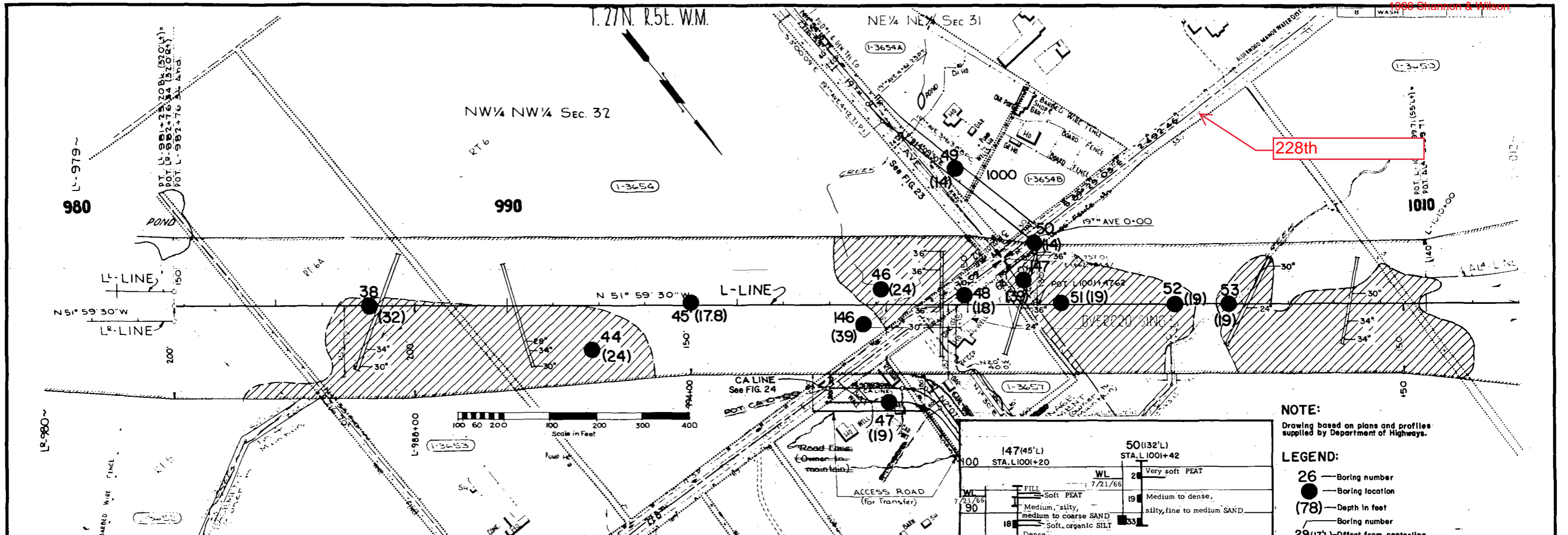
**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L' 948 TO L' 979**

AUGUST 1, 1966 W-66-965

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FIG. 6

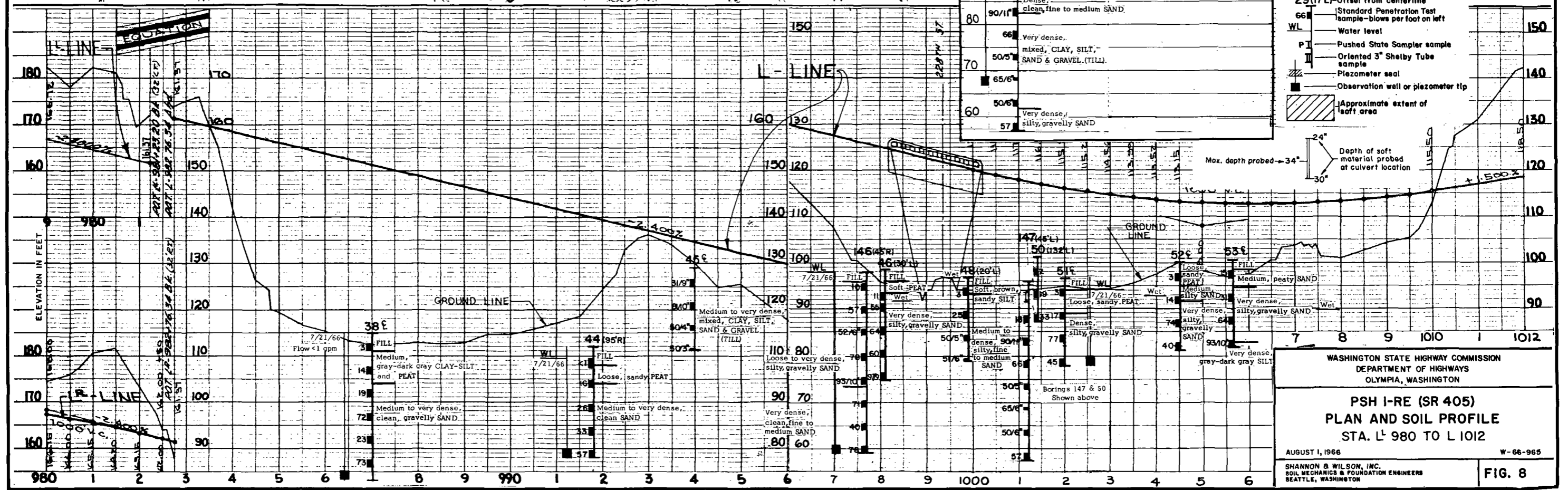


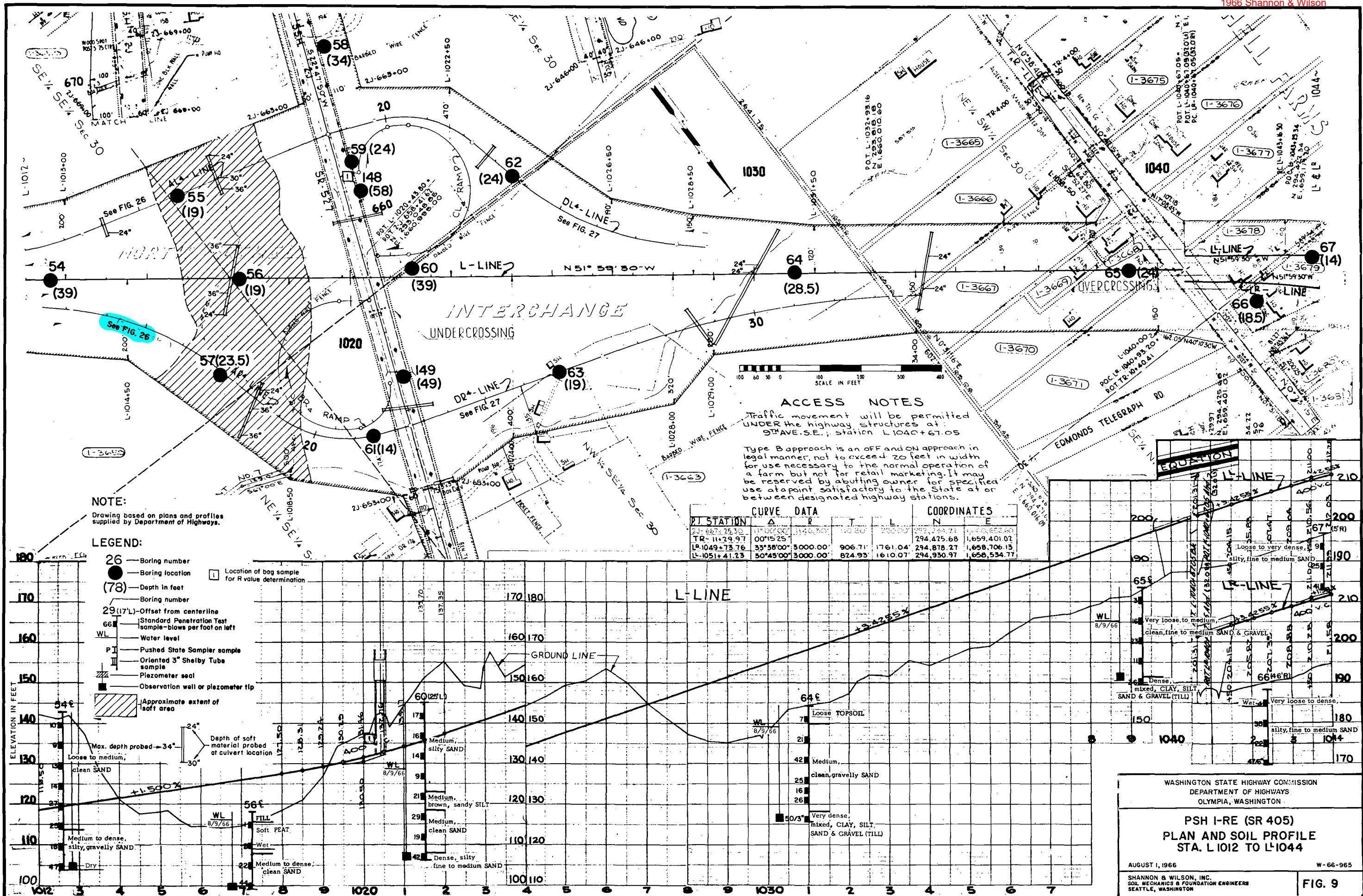


NOTE:
Drawing based on plans and profiles supplied by Department of Highways.

- LEGEND:**
- 26 — Boring number
 - — Boring location
 - (78) — Depth in feet
 - Boring number
 - 29 (17'L) — Offset from centerline
 - Standard Penetration Test sample — blows per foot on left
 - WL — Water level
 - PI — Pushed State Sampler sample
 - Oriented 3" Shelby Tube sample
 - ▨ — Piezometer seal
 - — Observation well or piezometer tip
 - ▨ — Approximate extent of soft area

Sta.	Depth (ft)	Soil Description
147 (45'L) <td>100</td> <td>Very soft PEAT</td>	100	Very soft PEAT
50 (132'L) <td>100</td> <td>Very soft PEAT</td>	100	Very soft PEAT
147 (45'L) <td>90</td> <td>Soft PEAT</td>	90	Soft PEAT
50 (132'L) <td>90</td> <td>Medium to dense, silty, fine to medium SAND</td>	90	Medium to dense, silty, fine to medium SAND
147 (45'L) <td>80</td> <td>Medium, silty, medium to coarse SAND</td>	80	Medium, silty, medium to coarse SAND
50 (132'L) <td>80</td> <td>Soft, organic SILT</td>	80	Soft, organic SILT
147 (45'L) <td>70</td> <td>Dense, clean, fine to medium SAND</td>	70	Dense, clean, fine to medium SAND
50 (132'L) <td>70</td> <td>Very dense, mixed, CLAY, SILT, SAND & GRAVEL (TILL)</td>	70	Very dense, mixed, CLAY, SILT, SAND & GRAVEL (TILL)
147 (45'L) <td>60</td> <td>Very dense, silty, gravelly SAND</td>	60	Very dense, silty, gravelly SAND
50 (132'L) <td>60</td> <td>Very dense, silty, gravelly SAND</td>	60	Very dense, silty, gravelly SAND





NOTE:
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- LEGEND:
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 - Boring number
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 - WL — Water level
 - P — Pushed State Sampler sample
 - Oriented 3" Shelby Tube sample
 - Piezometer seal
 - Observation well or piezometer tip
 - Approximate extent of soft area

ACCESS NOTES
Traffic movement will be permitted UNDER the highway structures at STAVE S.E.; station L 1040+67.05
Type B Approach is an OFF AND ON approach in legal manner, not to exceed 20 feet in width for use necessary to the normal operation of a farm but not for retail marketing. It may be reserved by abutting owner for specified use at a point satisfactory to the State at or between designated highway stations.

PT STATION	CURVE DATA			COORDINATES	
	Δ	R	T	N	E
2J-667+75.30	1°00'00"	1140.00'	19.80'	292,744.71	1,650,652.60
TR-11+29.97	00°15'25"			294,425.68	1,659,401.07
LR-1049+73.76	33°38'00"	3000.00'	906.71'	1761.04'	294,878.27
L-1051+41.23	50°45'00"	3000.00'	824.93'	1610.07'	294,930.97

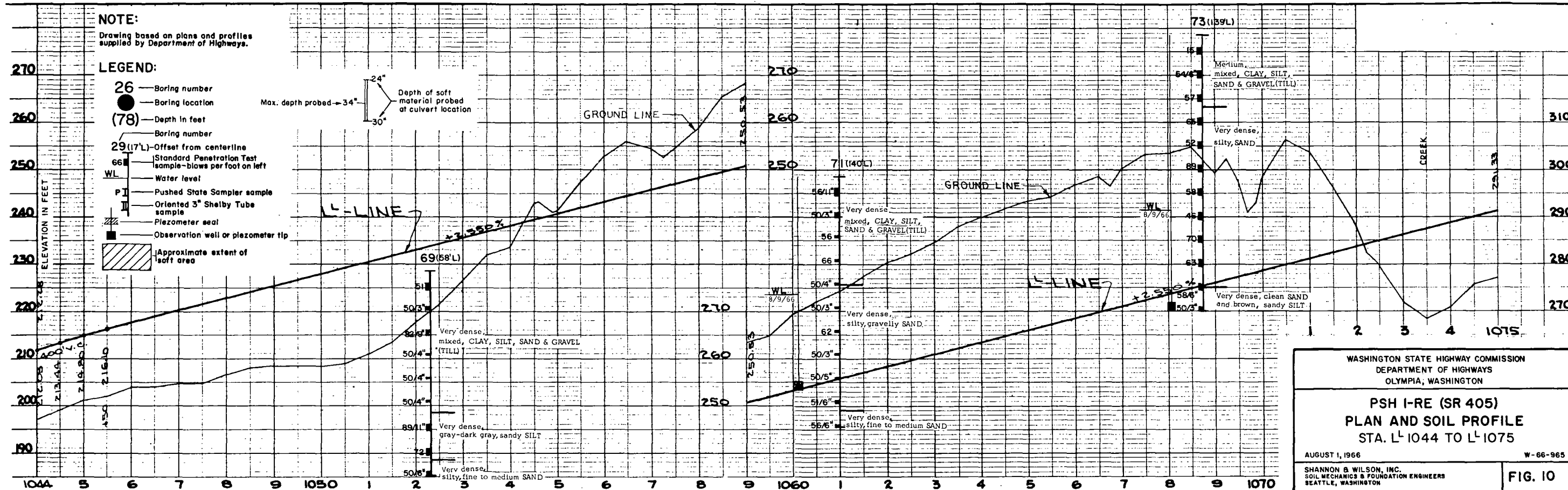
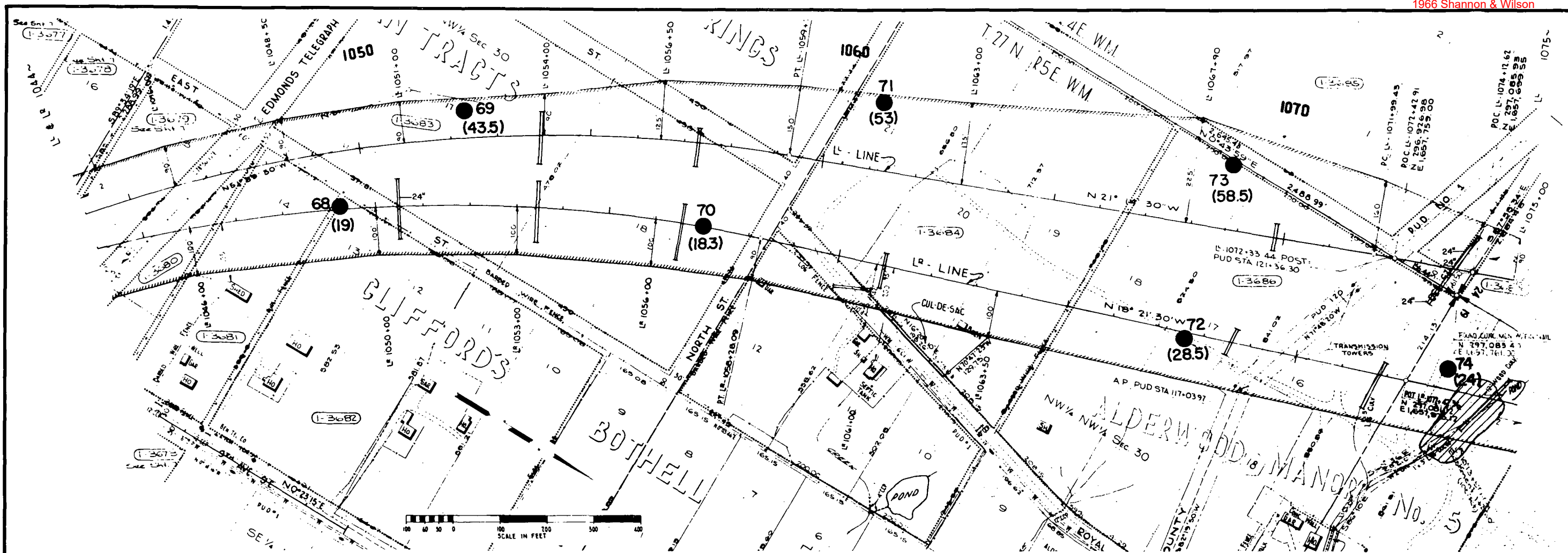
WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

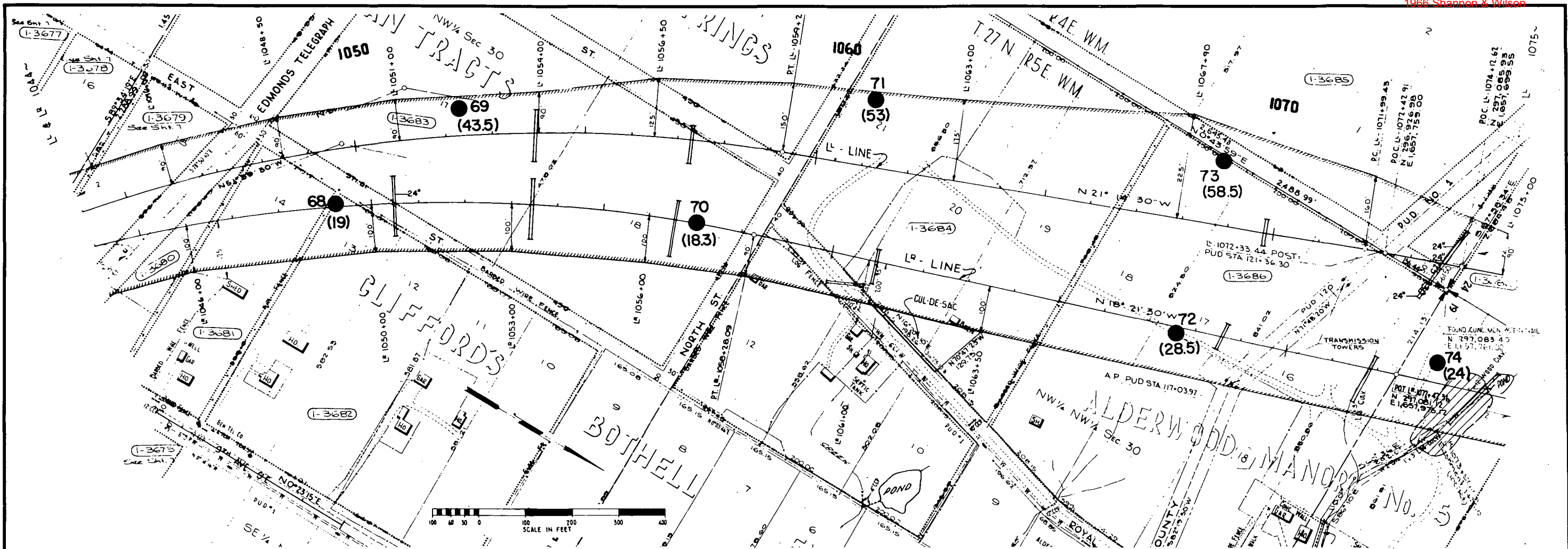
**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L 1012 TO L 1044**

AUGUST 1, 1966 W-66-965

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FIG. 9



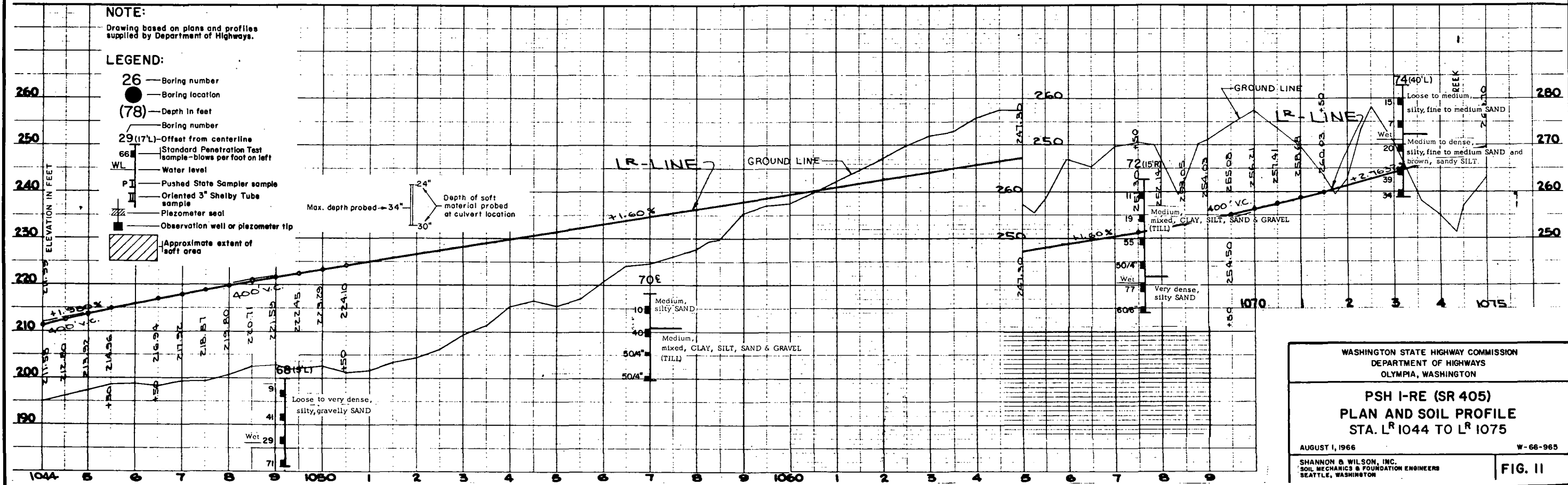
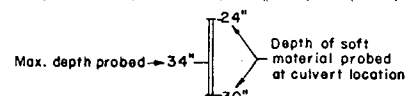


NOTE:

Drawing based on plans and profiles supplied by Department of Highways.

LEGEND:

- 26 — Boring number
- — Boring location
- (78) — Depth in feet
- Boring number
- 29(17L) — Offset from centerline
- 66 — Standard Penetration Test sample—blows per foot on left
- WL — Water level
- PI — Pushed State Sampler sample
- Oriented 3" Shelby Tube sample
- Piezometer seal
- Observation well or piezometer tip
- Approximate extent of soft area



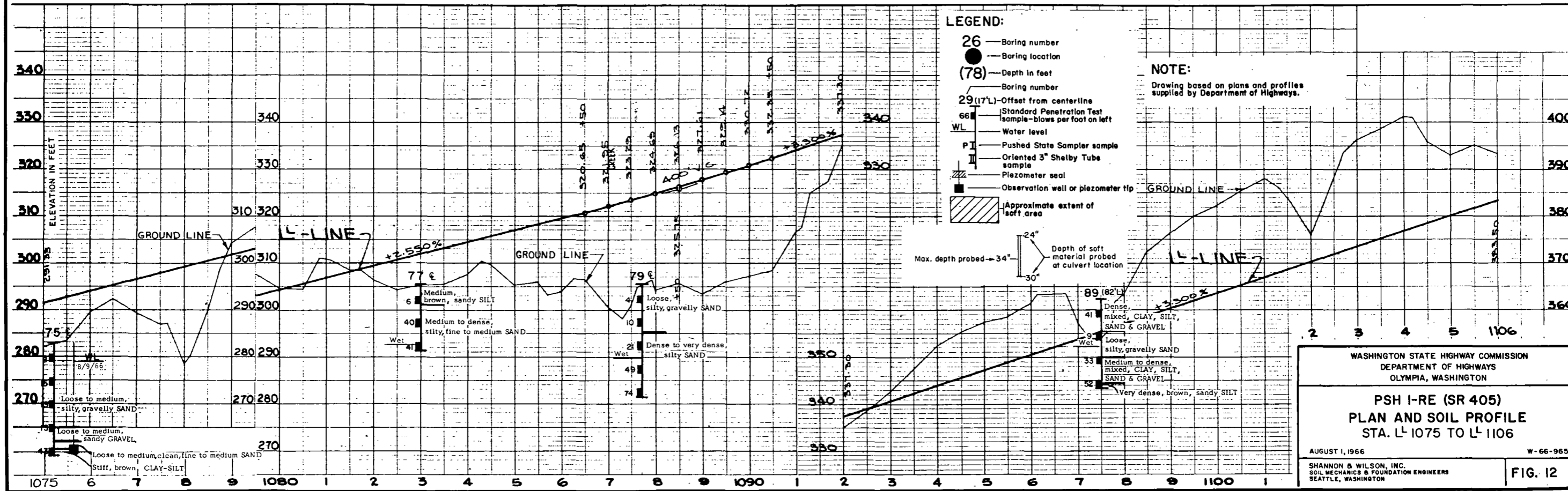
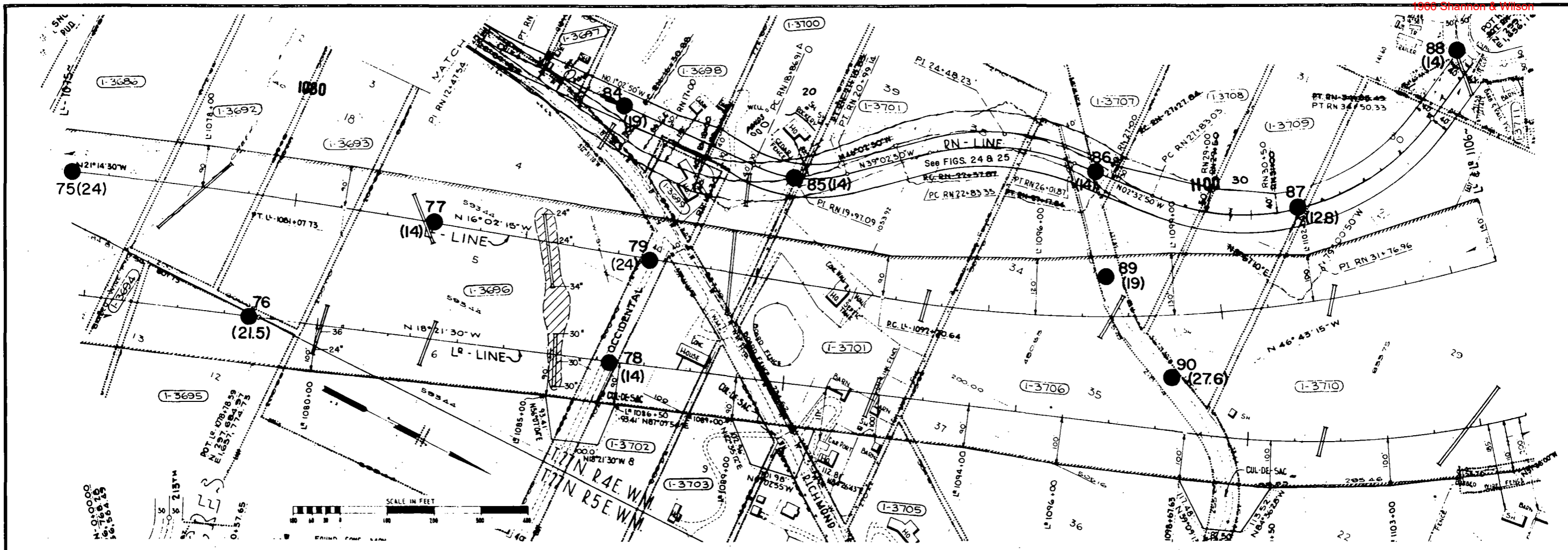
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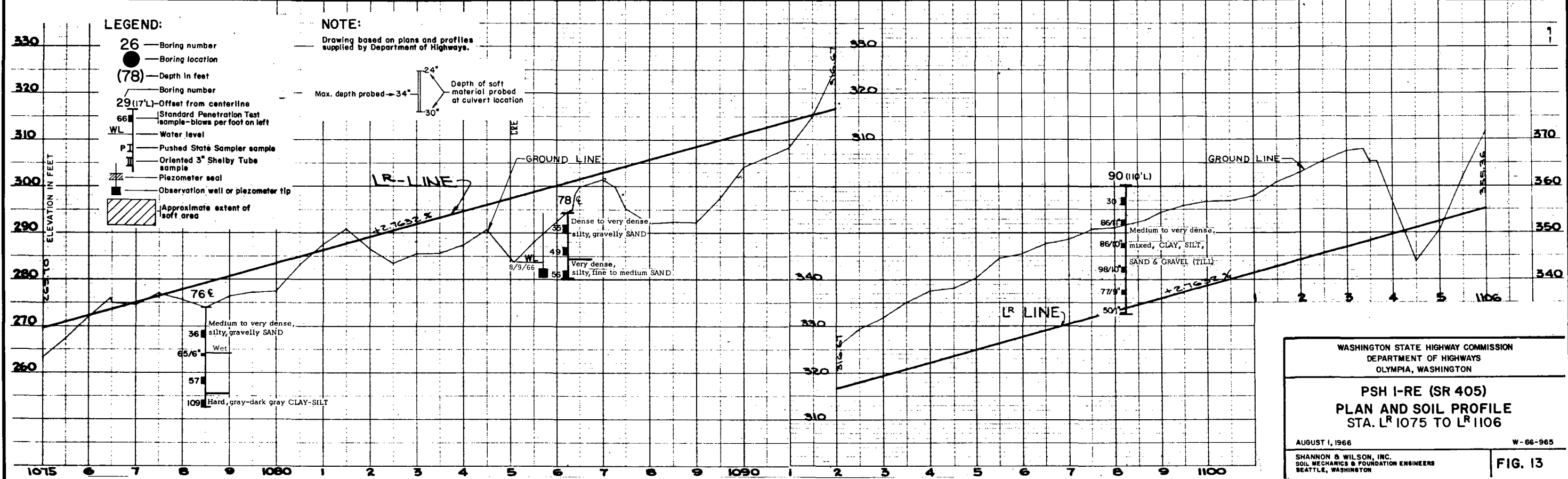
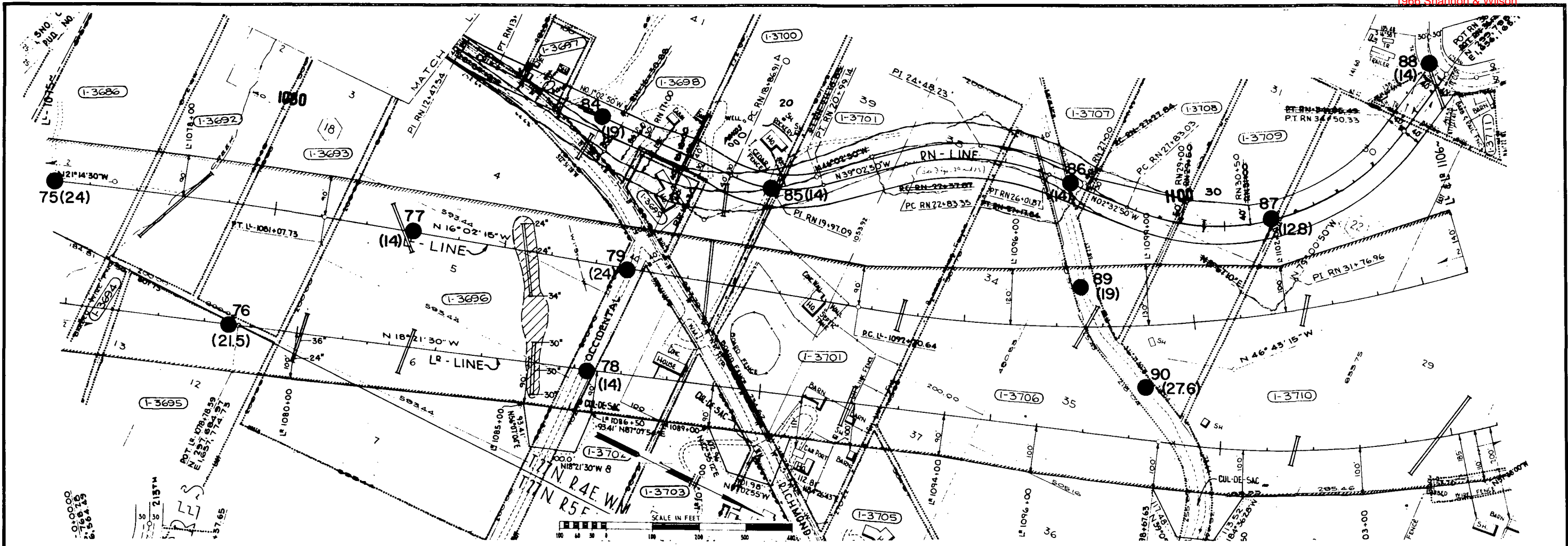
**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L^R 1044 TO L^R 1075**

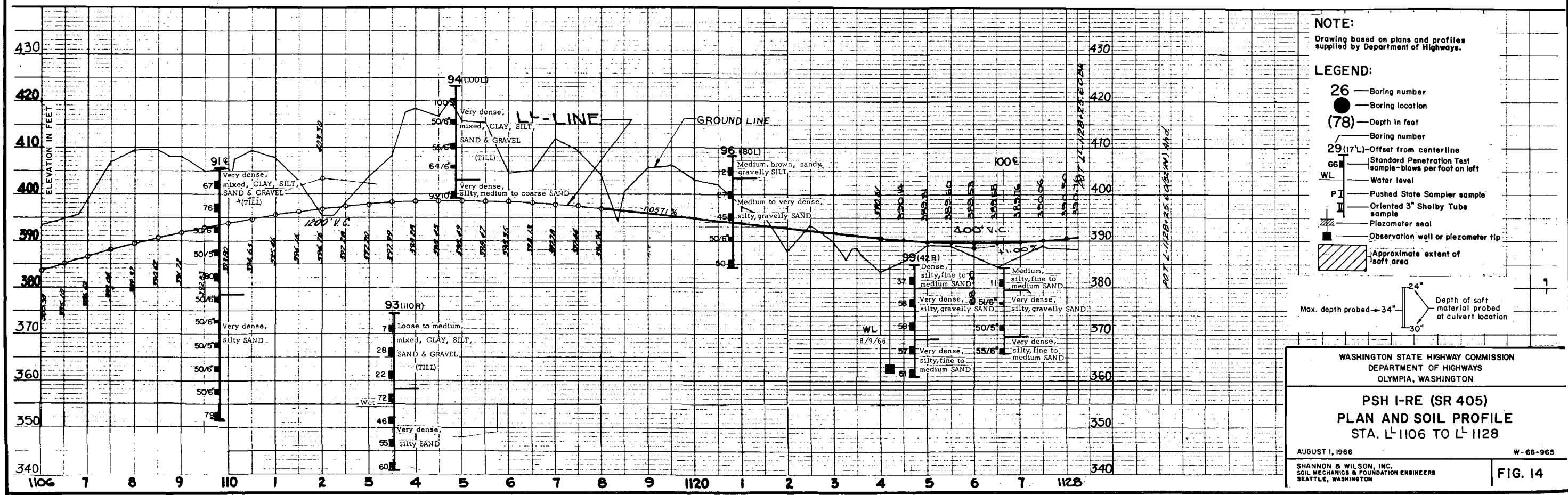
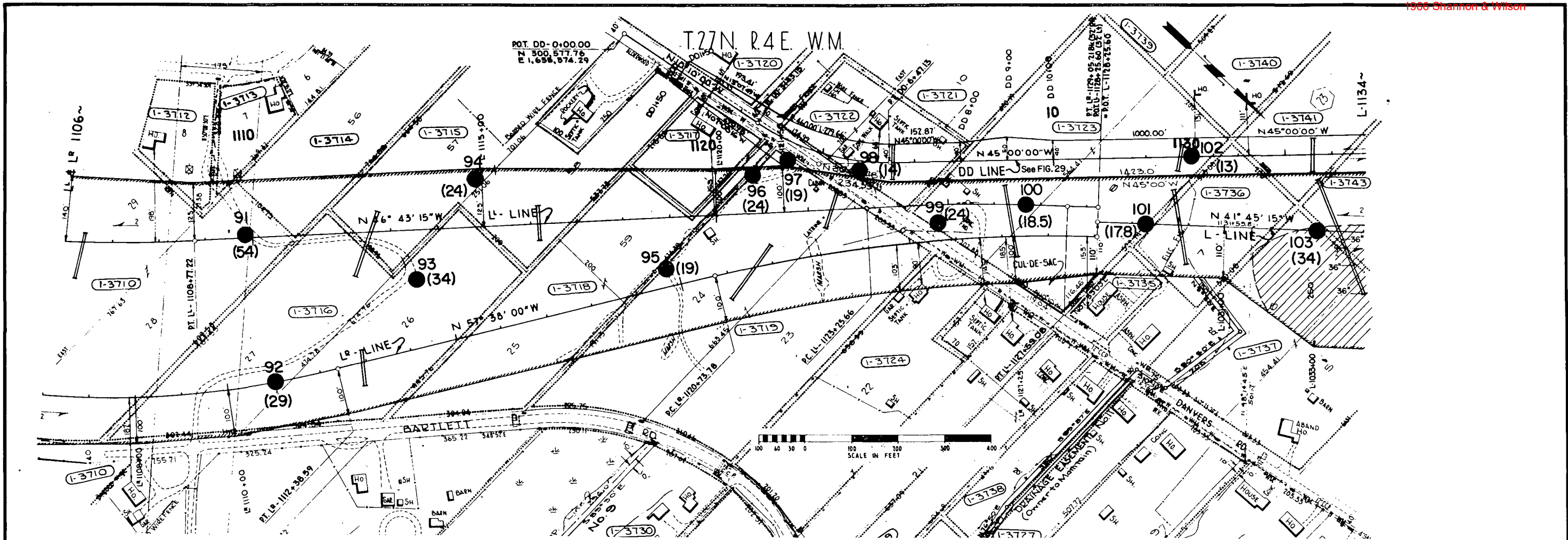
AUGUST 1, 1966 W-66-965

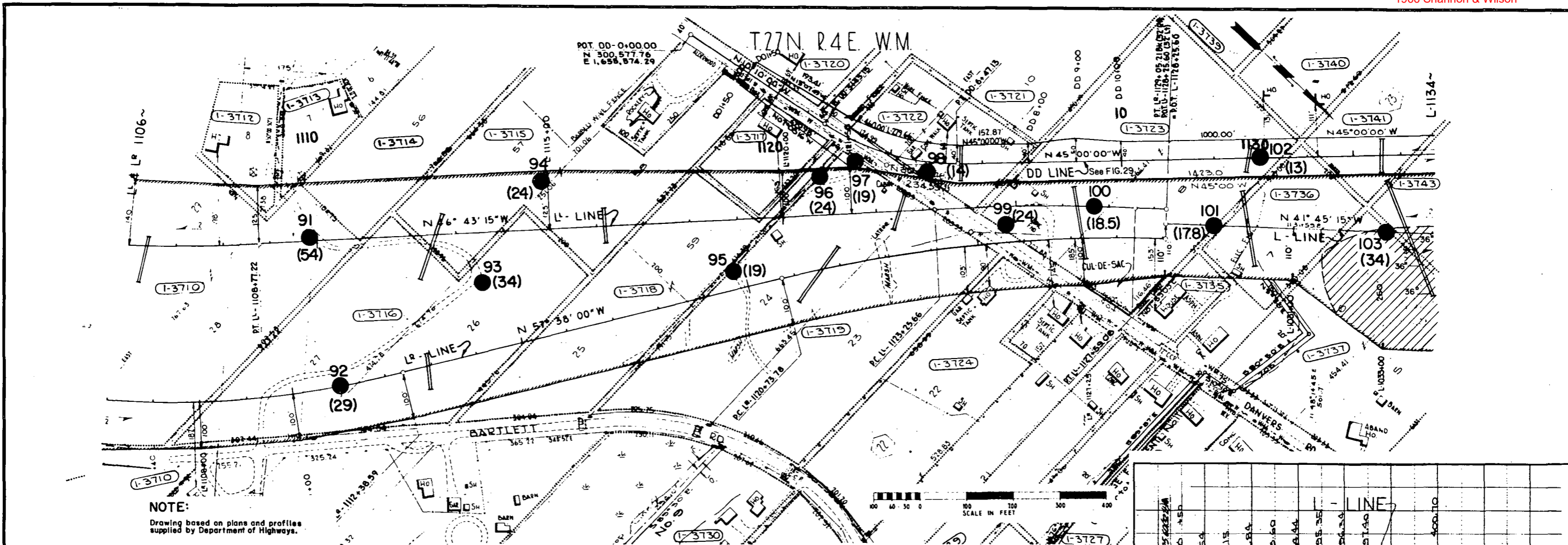
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FIG. 11



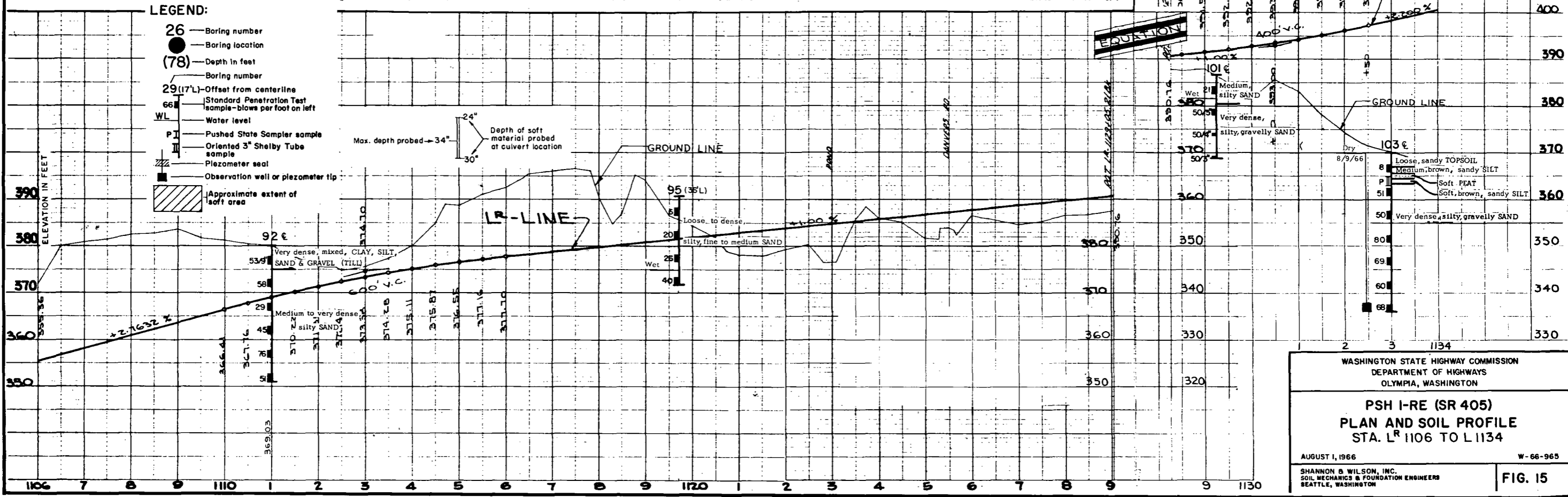






NOTE:
Drawing based on plans and profiles supplied by Department of Highways.

- LEGEND:**
- 26 — Boring number
 - — Boring location
 - (78) — Depth in feet
 - — Boring number
 - 29 (17'L) — Offset from centerline
 - 66 — Standard Penetration Test sample—blows per foot on left
 - WL — Water level
 - PI — Pushed State Sampler sample
 - — Oriented 3" Shelby Tube sample
 - — Piezometer seal
 - — Observation well or piezometer tip
 - ▨ — Approximate extent of soft area



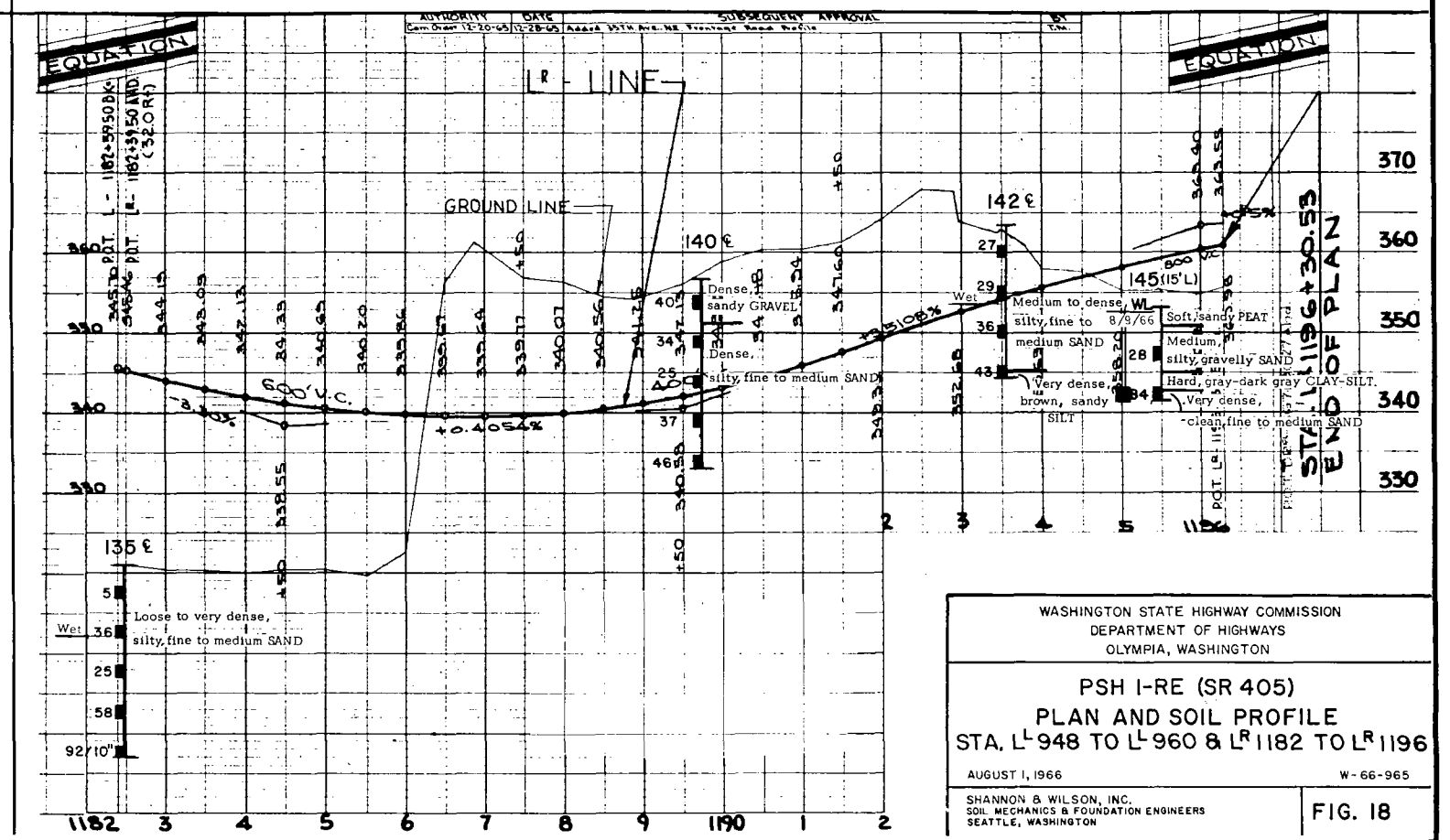
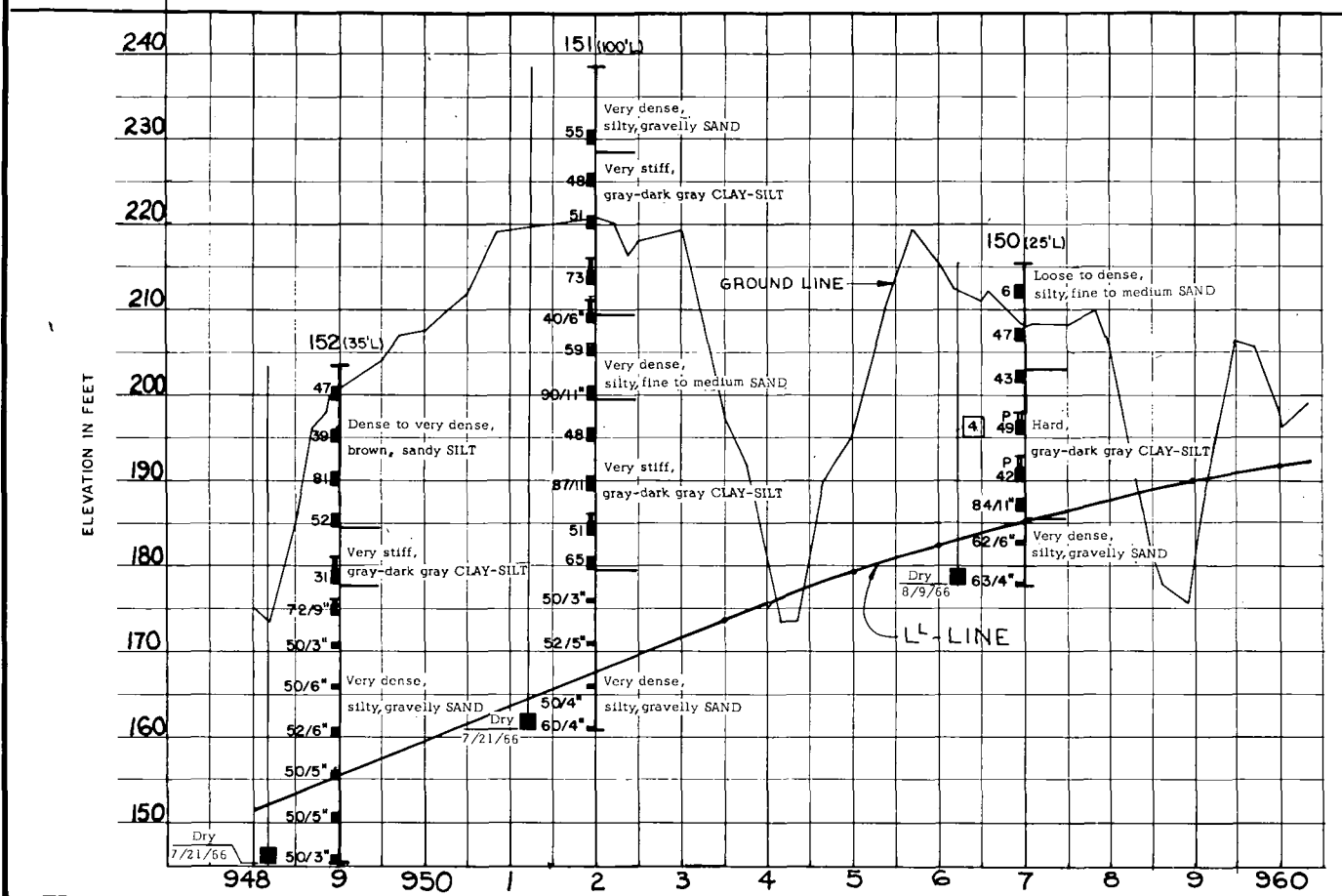
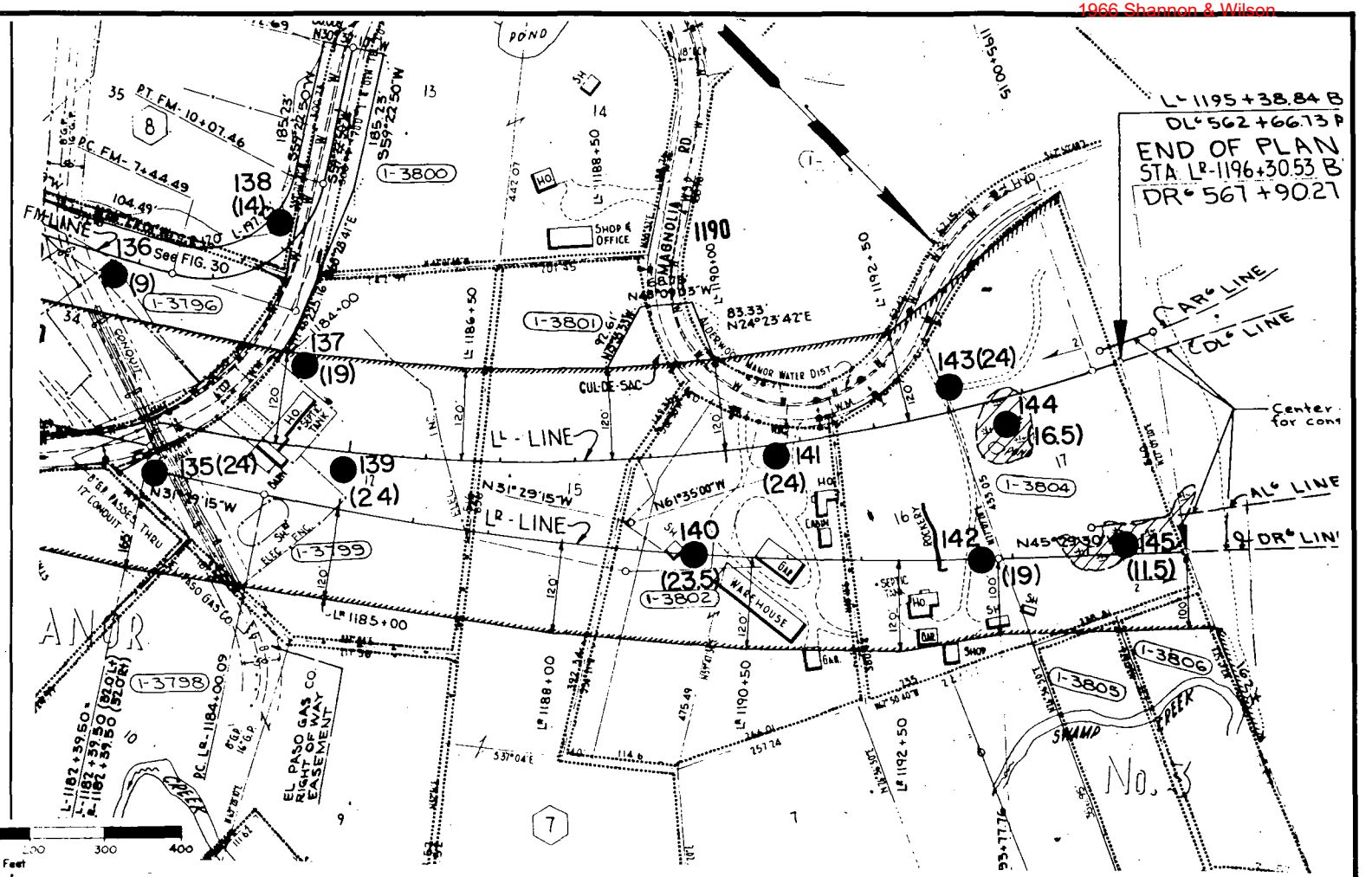
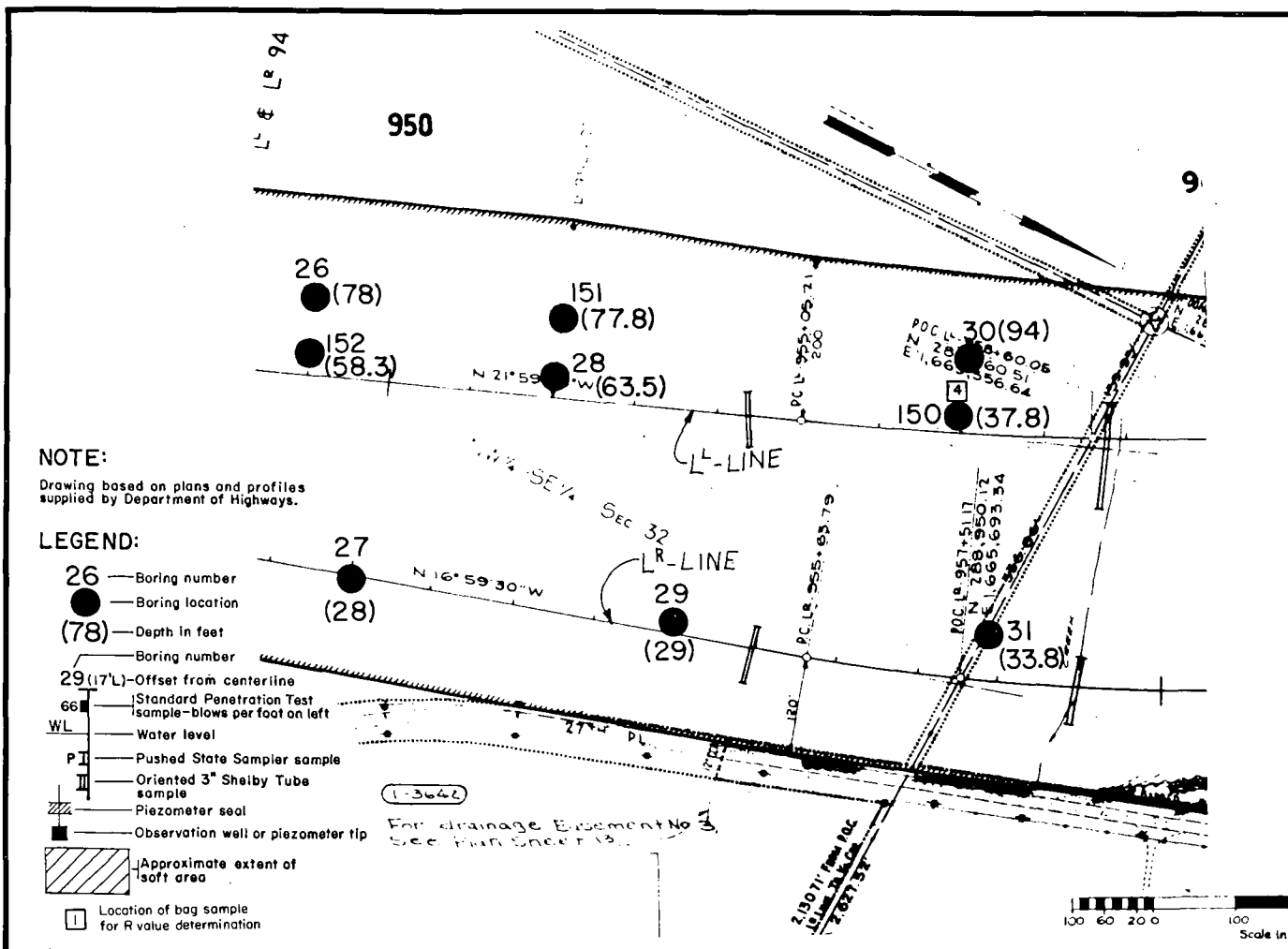
WASHINGTON STATE HIGHWAY COMMISSION
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**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L^R 1106 TO L 1134**

AUGUST 1, 1966 W-66-965

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FIG. 15



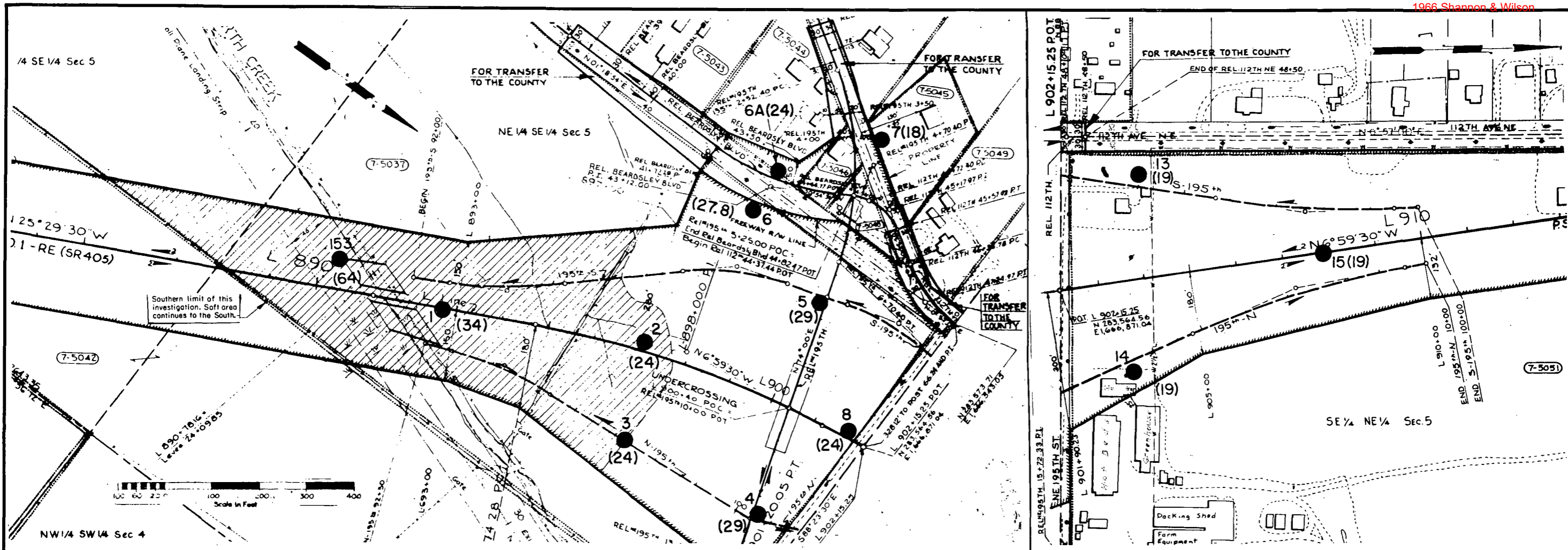
WASHINGTON STATE HIGHWAY COMMISSION
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PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
STA. L^R 948 TO L^R 960 & L^R 1182 TO L^R 1196

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FIG. 18

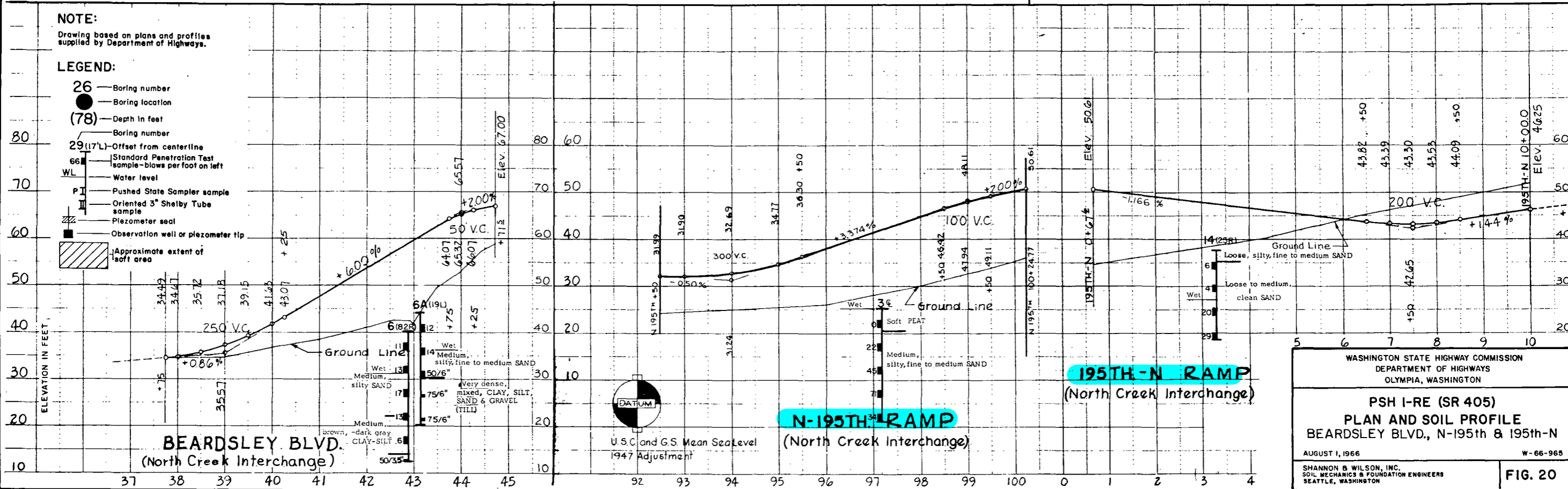


NOTE:

Drawing based on plans and profiles supplied by Department of Highways.

LEGEND:

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- — Boring location
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- Boring number
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- PI — Pushed State Sampler sample
- Oriented 3" Shelby Tube sample
- Piezometer seal
- Observation well or piezometer tip
- Approximate extent of soft area



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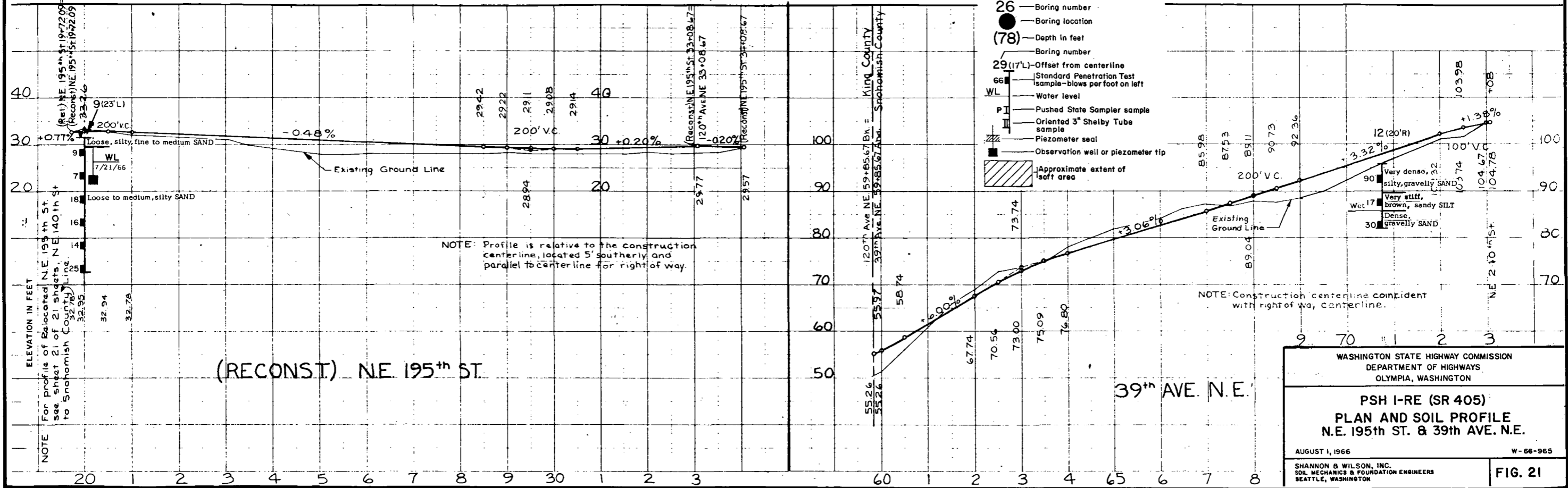
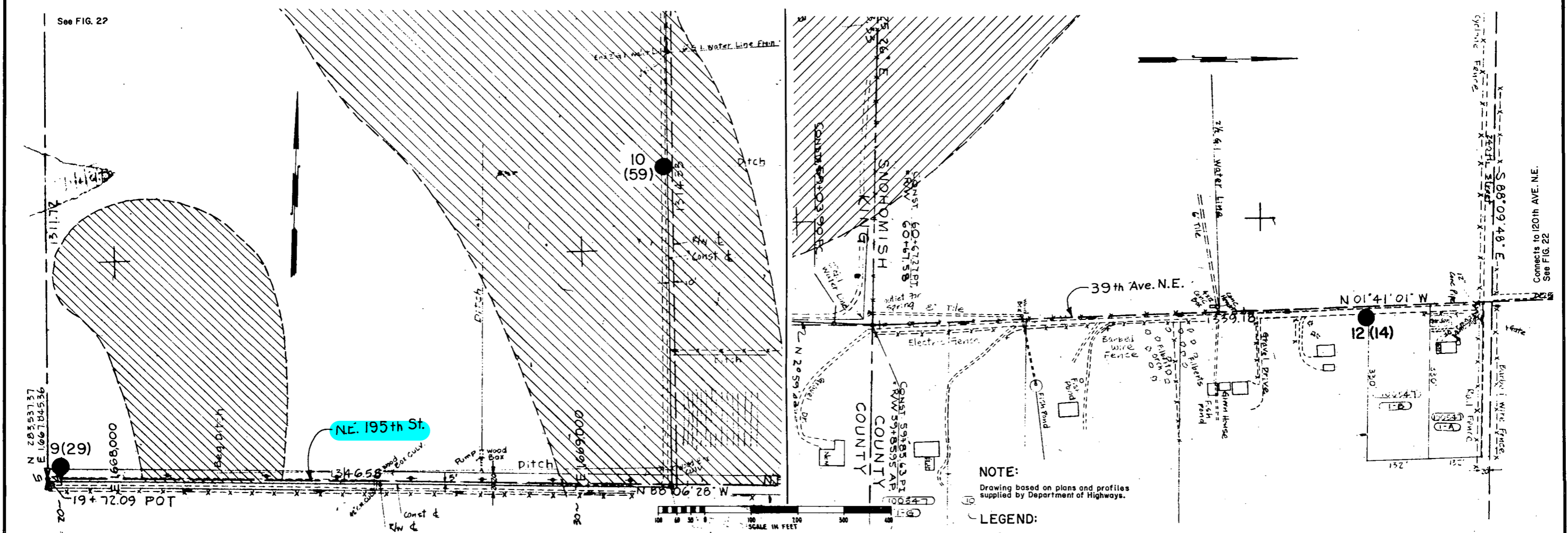
PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
BEARDSLEY BLVD., N-195th & 195th-N

AUGUST 1, 1966 W-66-965

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FIG. 20

See FIG. 22



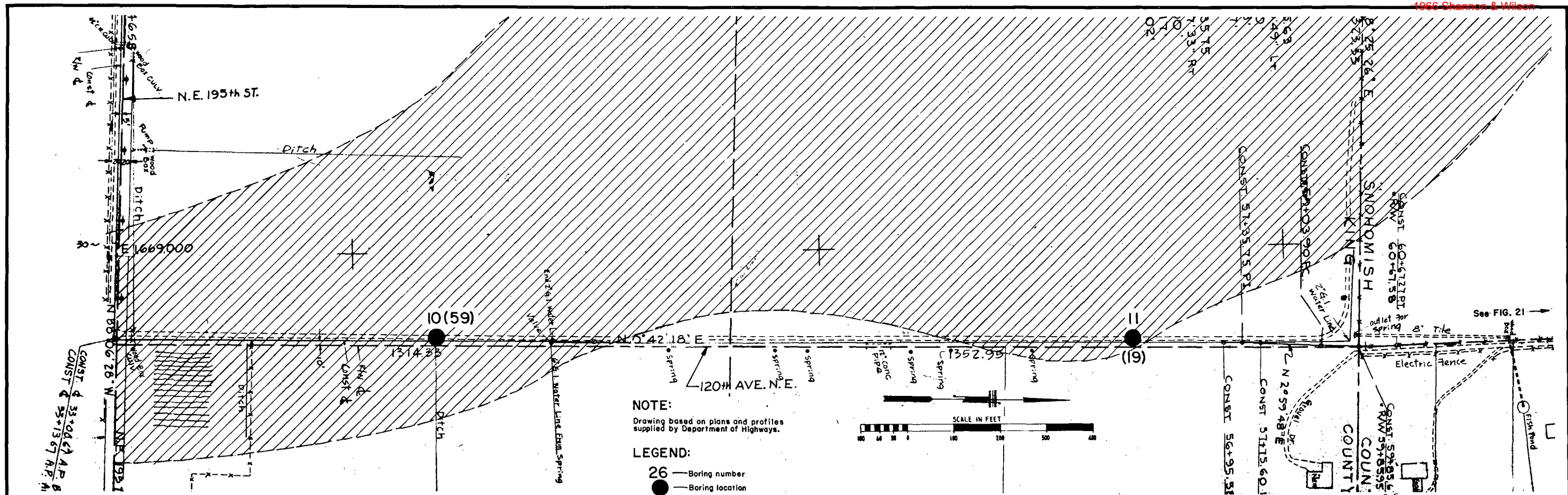
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**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
N.E. 195th ST. & 39th AVE. N.E.**

AUGUST 1, 1966 W-66-965

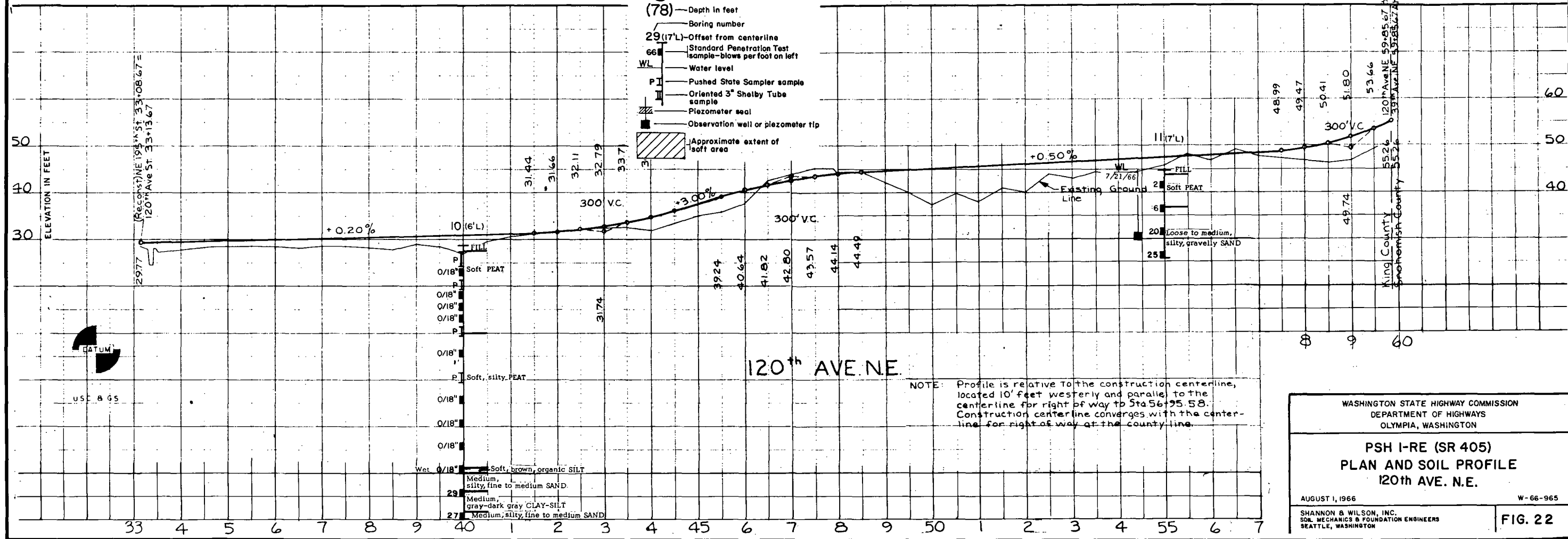
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SEATTLE, WASHINGTON

FIG. 21



NOTE:
Drawing based on plans and profiles supplied by Department of Highways.

- LEGEND:**
- 26 — Boring number
 - — Boring location
 - (78) — Depth in feet
 - 29 (17'L) — Boring number
 - 29 (17'L) — Offset from centerline
 - 66 — Standard Penetration Test (sample—blows per foot on left)
 - WL — Water level
 - PJ — Pushed State Sampler sample
 - Oriented 3" Shelby Tube sample
 - Piezometer seal
 - Observation well or piezometer tip
 - Approximate extent of soft area



NOTE: Profile is relative to the construction centerline, located 10' feet westerly and parallel to the centerline for right of way to Sta 56+95.58. Construction centerline converges with the centerline for right of way at the county line.

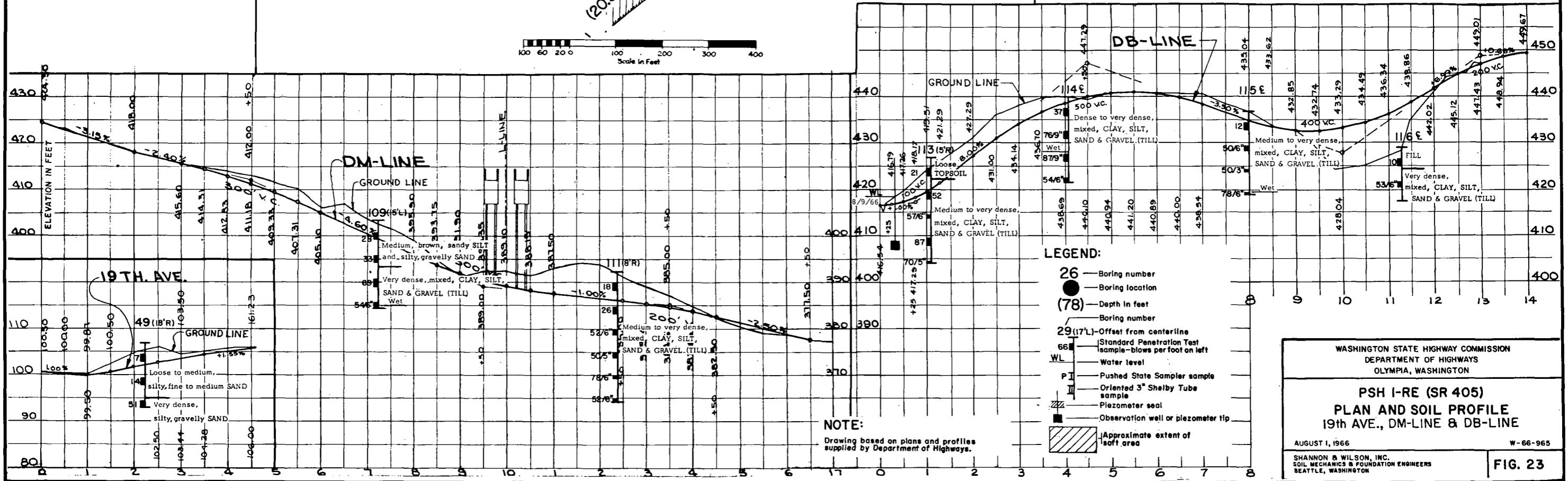
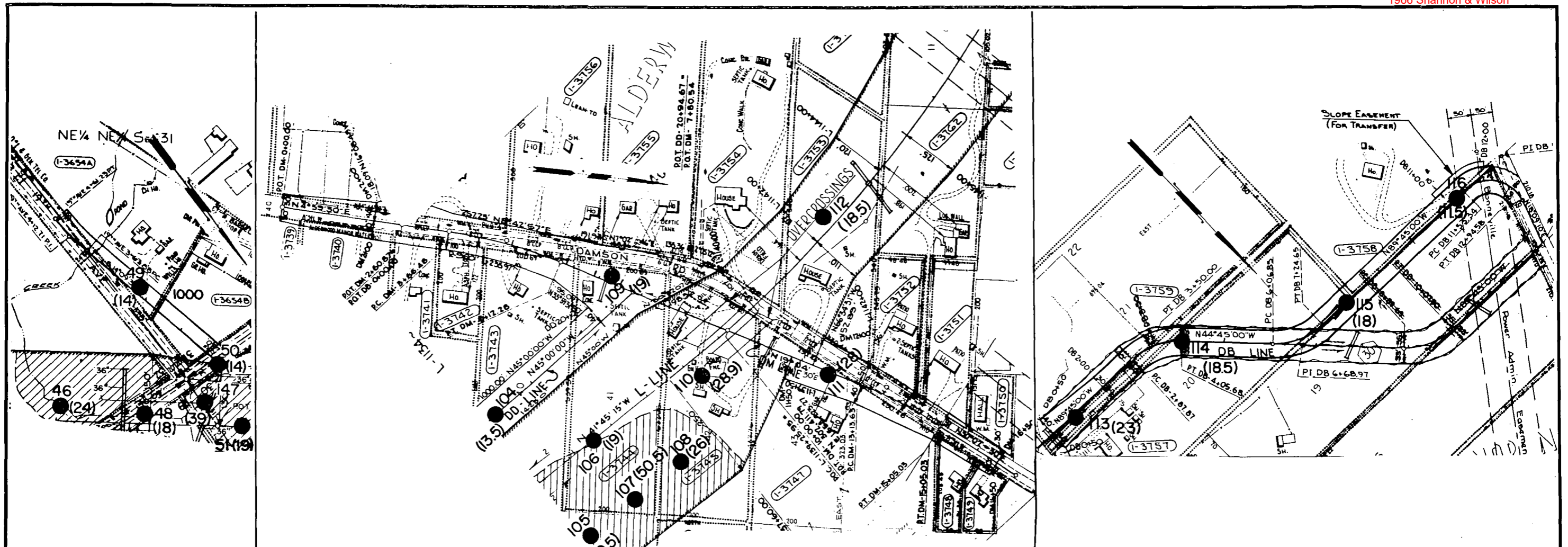
WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
120th AVE. N.E.**

AUGUST 1, 1966 W-66-965

SHANNON & WILSON, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS
SEATTLE, WASHINGTON

FIG. 22



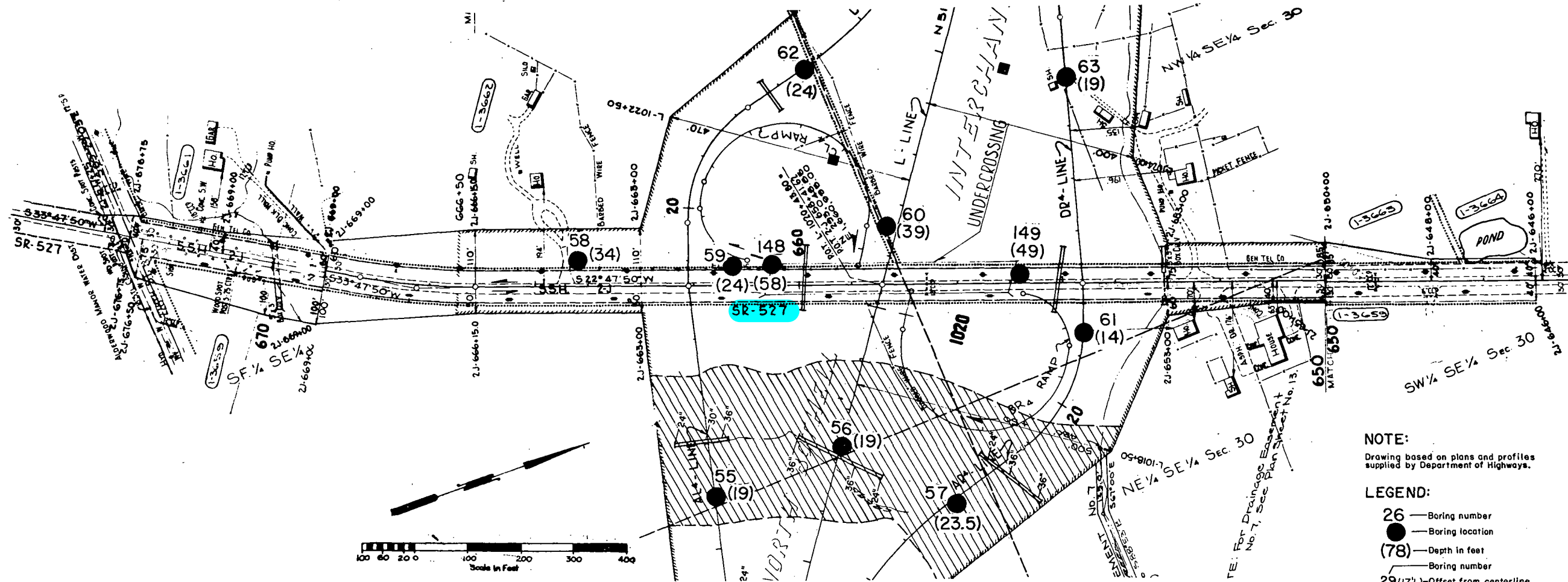
WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
19th AVE., DM-LINE & DB-LINE

AUGUST 1, 1966 W-66-965

SHANNON & WILSON, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS
SEATTLE, WASHINGTON

FIG. 23

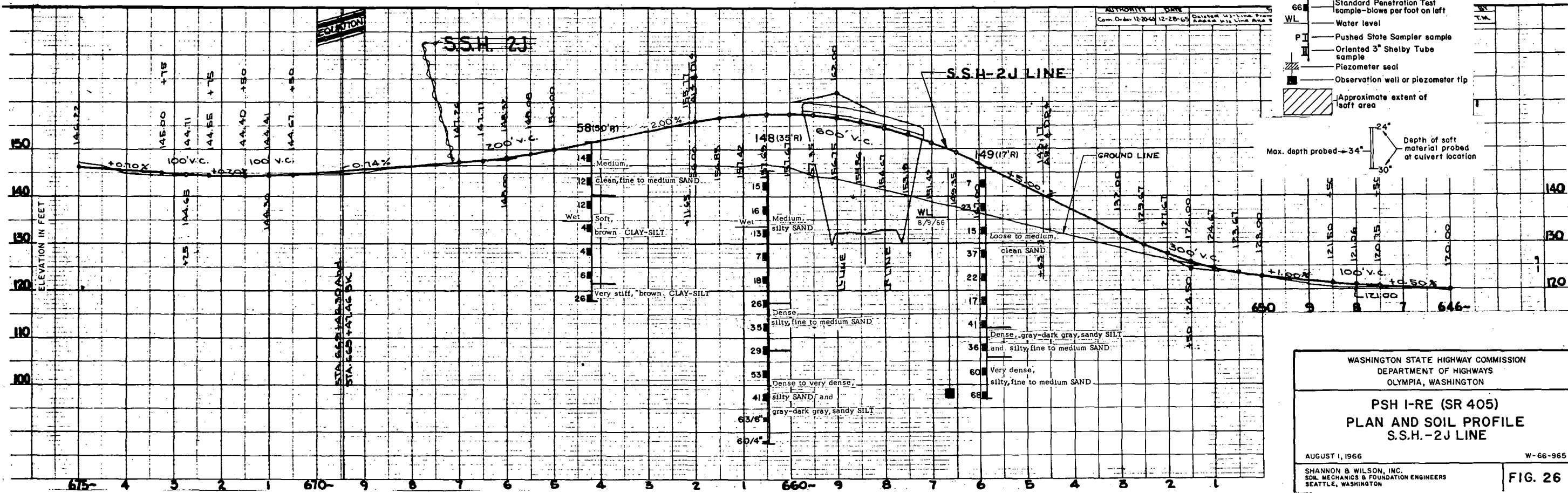
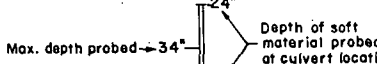


NOTE:

Drawing based on plans and profiles supplied by Department of Highways.

LEGEND:

- 26 — Boring number
- — Boring location
- (78) — Depth in feet
- — Boring number
- 29(17'L) — Offset from centerline
- Standard Penetration Test sample — blows per foot on left
- WL — Water level
- PI — Pushed State Sampler sample
- Oriented 3" Shelby Tube sample
- ▨ — Piezometer seal
- — Observation well or piezometer tip
- ▨ — Approximate extent of soft area

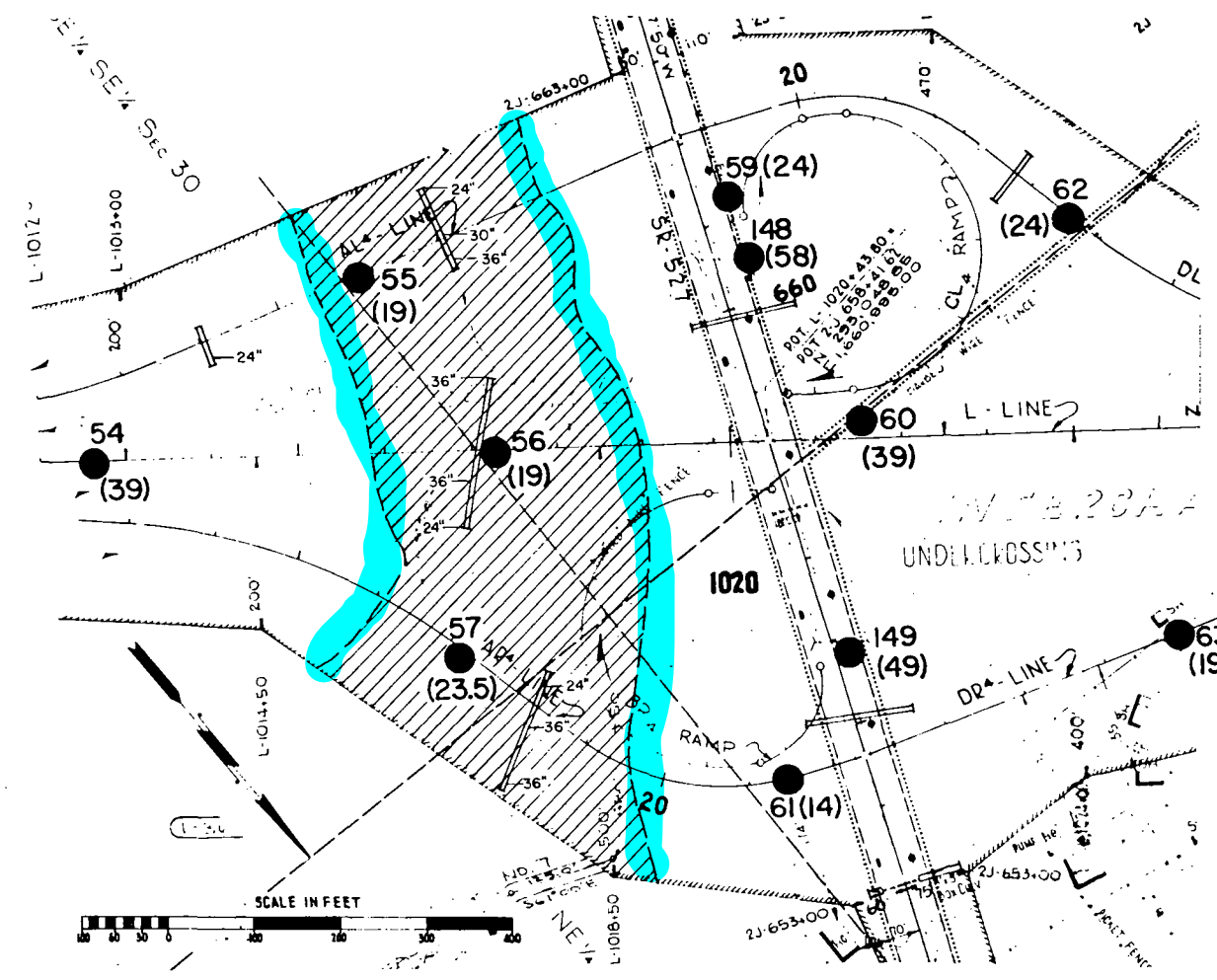


WASHINGTON STATE HIGHWAY COMMISSION
 DEPARTMENT OF HIGHWAYS
 OLYMPIA, WASHINGTON

**PSH I-RE (SR 405)
 PLAN AND SOIL PROFILE
 S.S.H. -2J LINE**

AUGUST 1, 1966 W-66-965

SHANNON & WILSON, INC.
 SOIL MECHANICS & FOUNDATION ENGINEERS
 SEATTLE, WASHINGTON FIG. 26

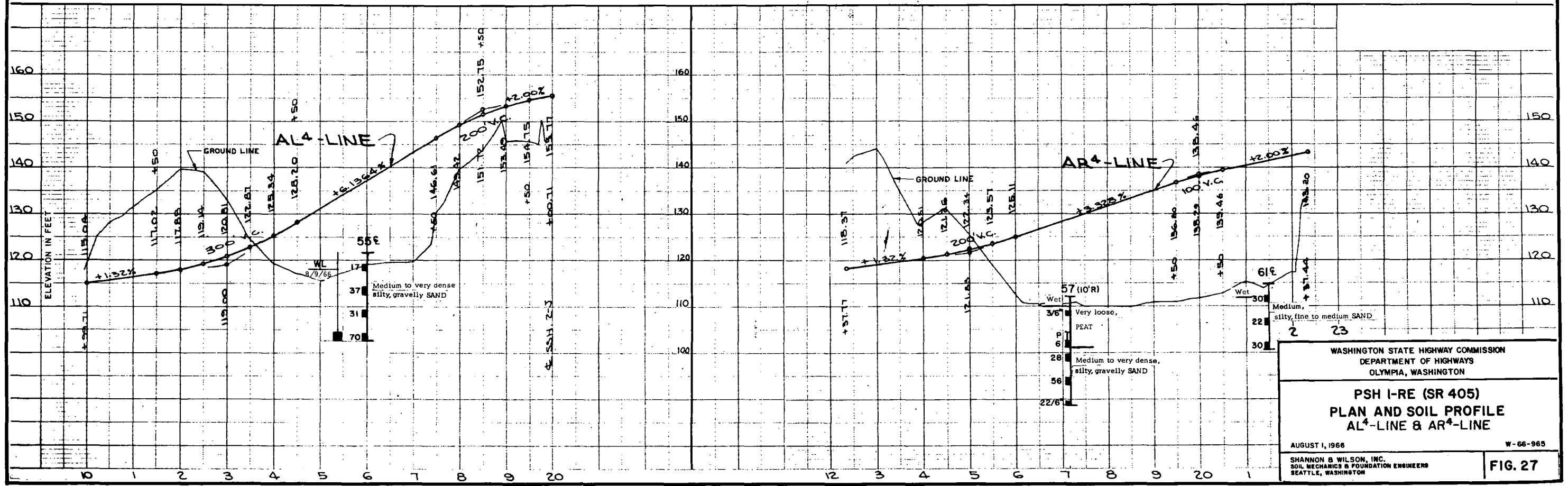


NOTE:
Drawing based on plans and profiles supplied by Department of Highways.

LEGEND:

- 26 — Boring number
- — Boring location
- (78) — Depth in feet
- Boring number
- 29 (17'L) — Offset from centerline
- 66 — Standard Penetration Test sample—blows per foot on left
- WL — Water level
- P — Pushed State Sampler sample
- Oriented 3" Shelby Tube sample
- Piezometer seal
- Observation well or piezometer tip
- Approximate extent of soft area

Max. depth probed → 34" — Depth of soft material probed at culvert location



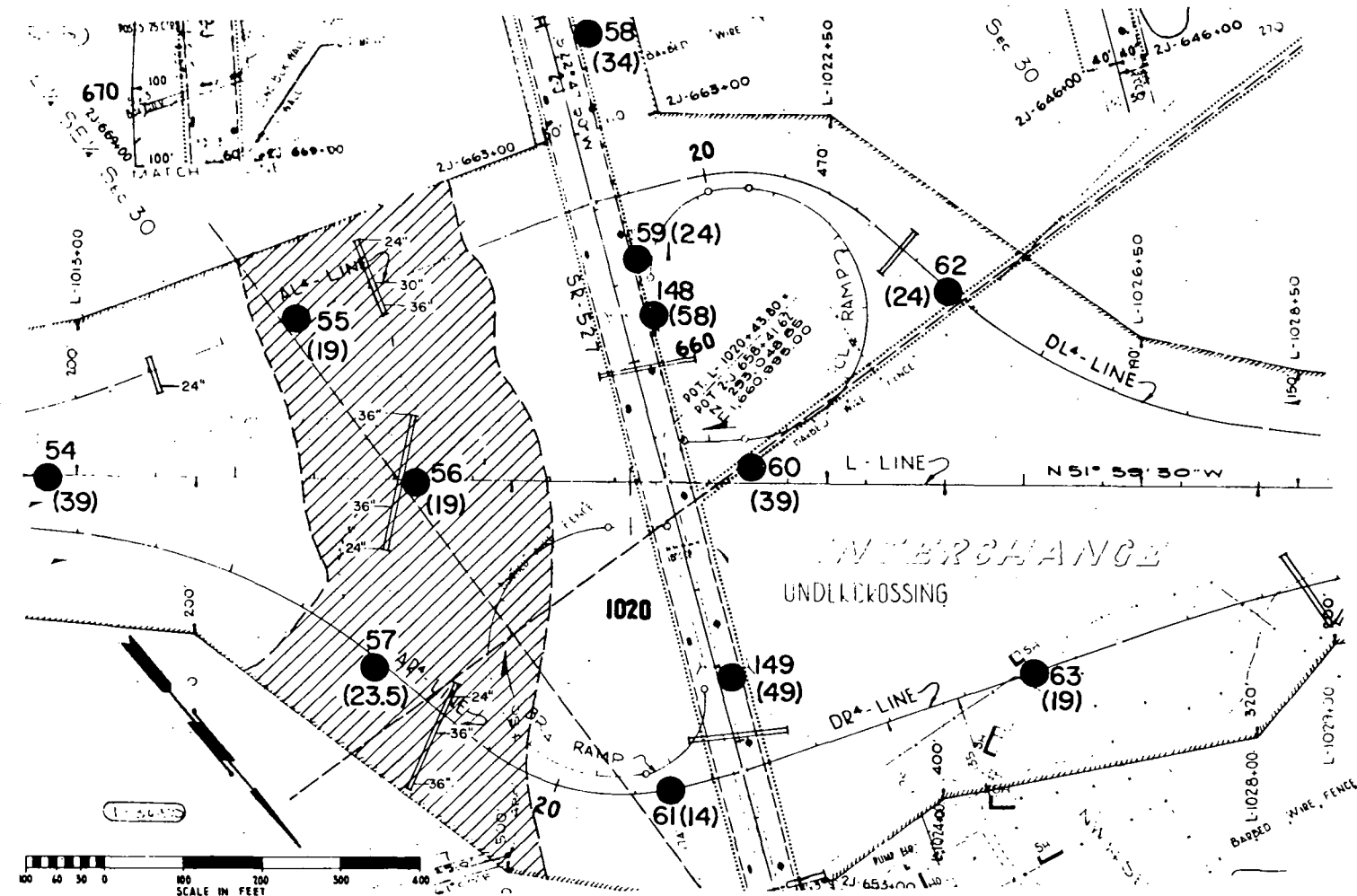
WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
AL⁴-LINE & AR⁴-LINE**

AUGUST 1, 1966 W-66-965

SHANNON & WILSON, INC.
SOIL MECHANICS & FOUNDATION ENGINEERS
SEATTLE, WASHINGTON

FIG. 27

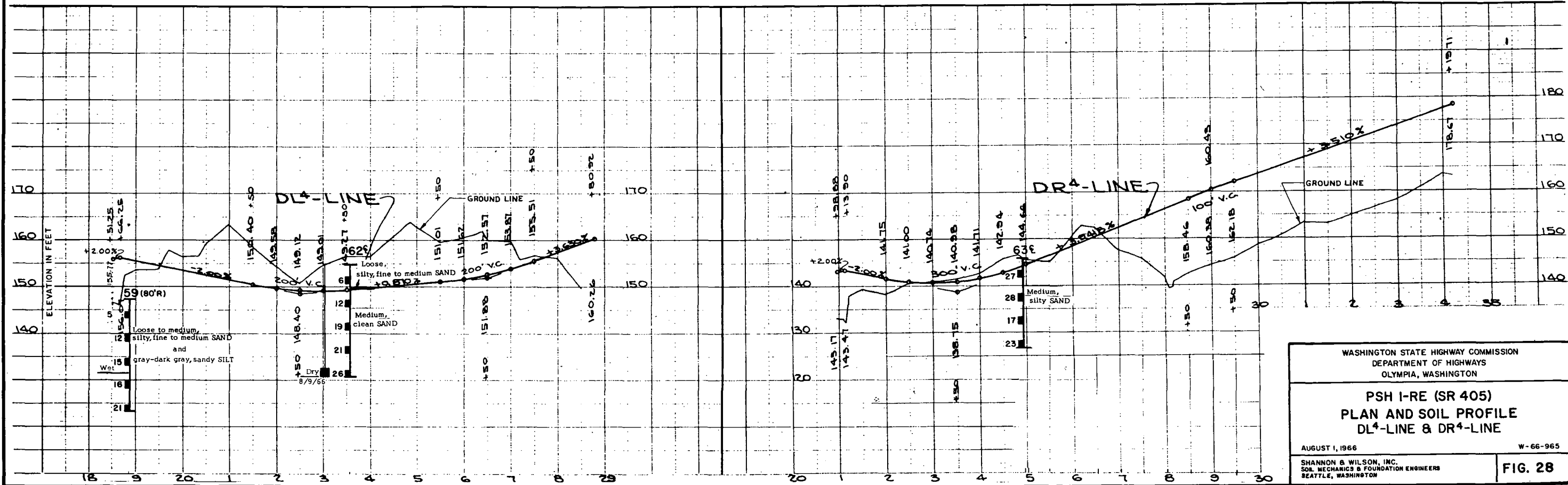


NOTE:

Drawing based on plans and profiles supplied by Department of Highways.

LEGEND:

- 26 — Boring number
 - — Boring location
 - (78) — Depth in feet
 - Boring number
 - 29 (17'L) — Offset from centerline
 - 66 — Standard Penetration Test sample—blows per foot on left
 - WL — Water level
 - P I — Pushed State Sampler sample
 - Oriented 3" Shelby Tube sample
 - Piezometer seal
 - Observation well or piezometer tip
 - Approximate extent of soft area
- Max. depth probed → 34" — Depth of soft material probed at culvert location



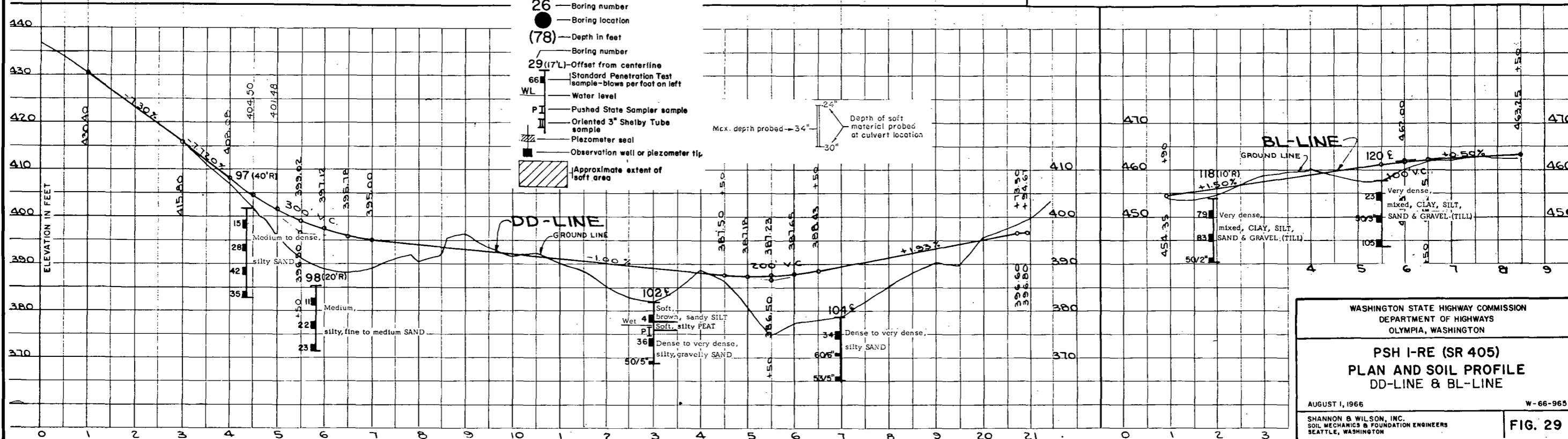
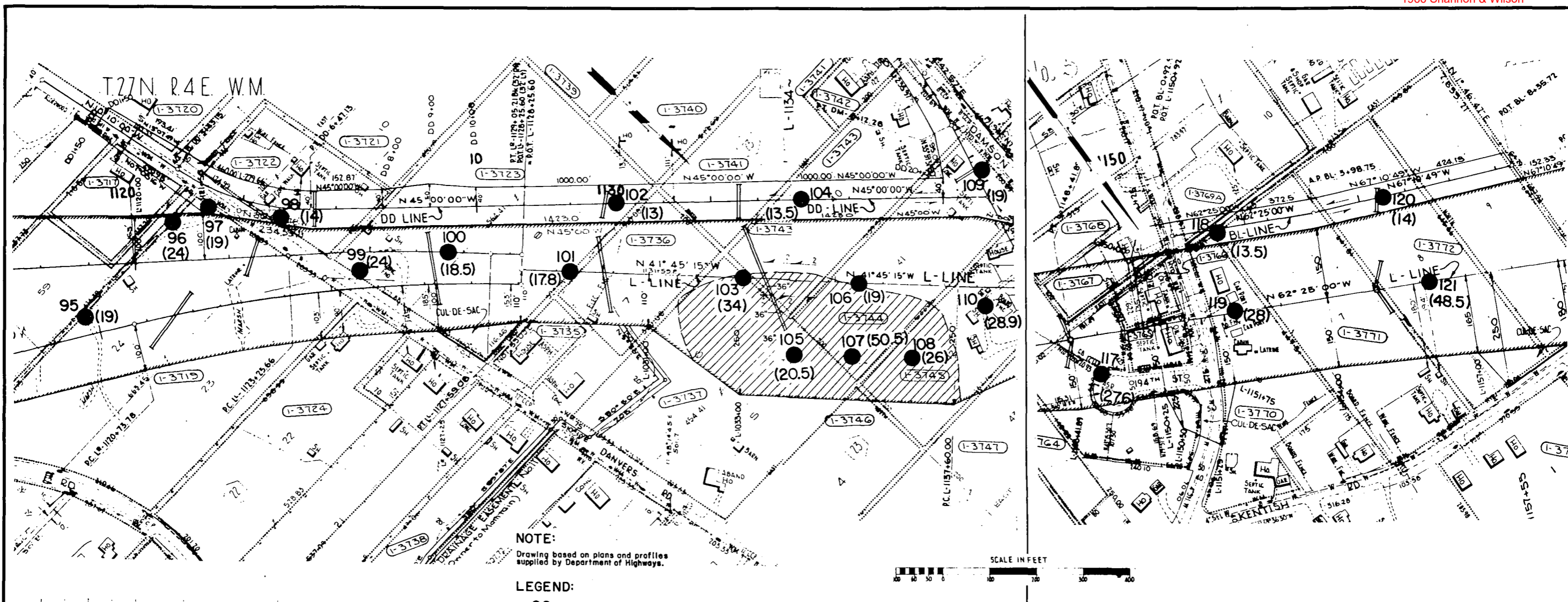
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 DEPARTMENT OF HIGHWAYS
 OLYMPIA, WASHINGTON

**PSH I-RE (SR 405)
 PLAN AND SOIL PROFILE
 DL4-LINE & DR4-LINE**

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FIG. 28



WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

**PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
DD-LINE & BL-LINE**

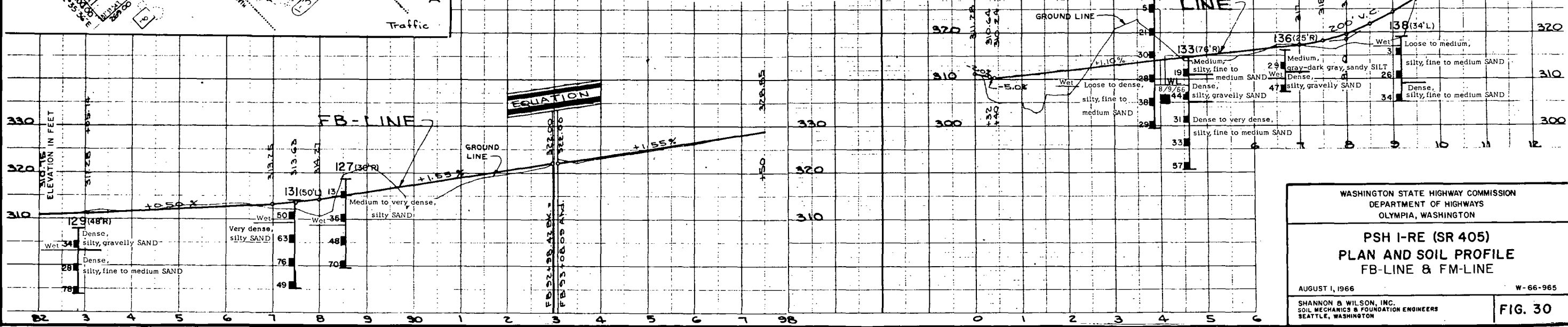
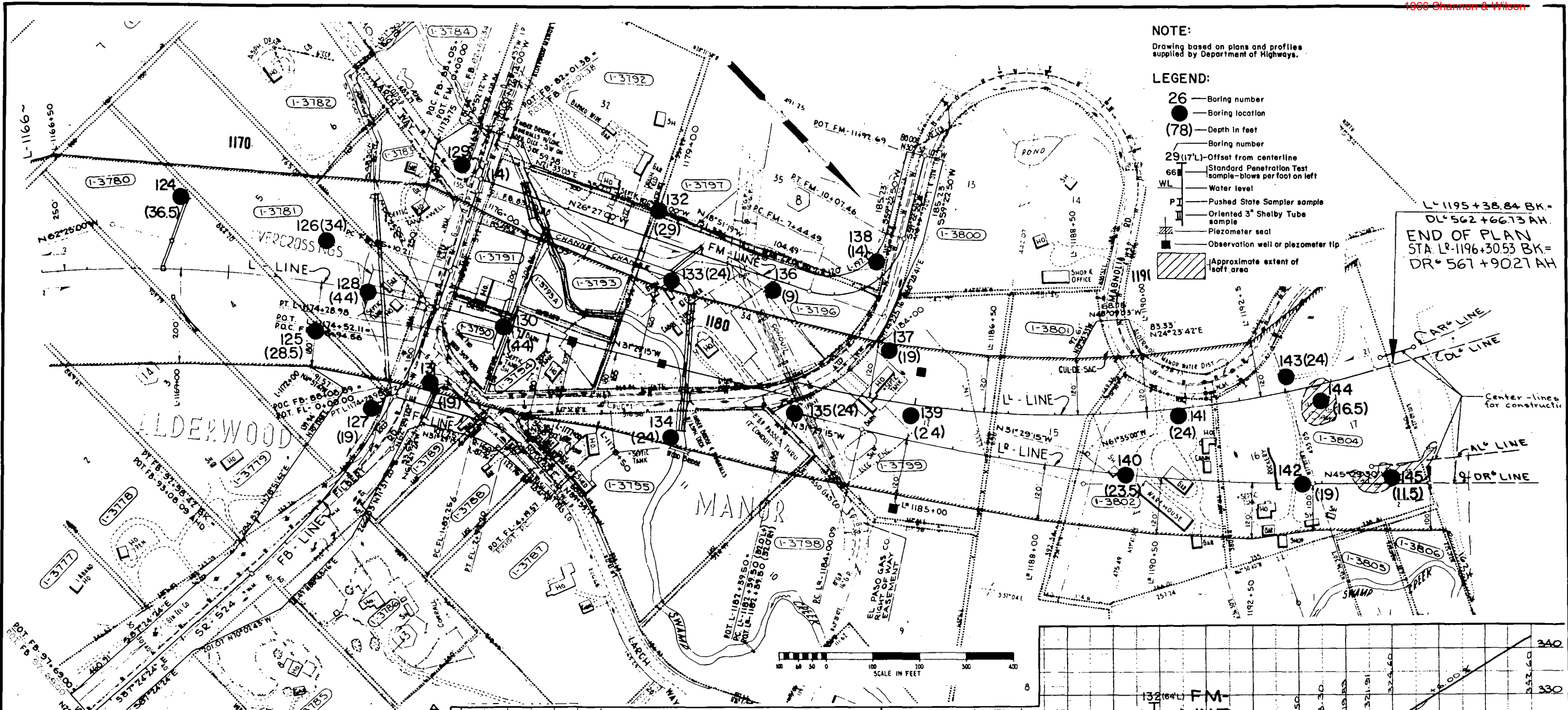
AUGUST 1, 1966
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SOIL MECHANICS & FOUNDATION ENGINEERS
SEATTLE, WASHINGTON

W-66-965
FIG. 29

NOTE:
Drawing based on plans and profiles supplied by Department of Highways.

- LEGEND:**
- 26 — Boring number
 - — Boring location
 - (78) — Depth in feet
 - — Boring number
 - 29(17'L) — Offset from centerline
 - 66 — Standard Penetration Test sample—blows per foot on left
 - WL — Water level
 - PT — Pushed State Sampler sample
 - Oriented 3" Shelby Tube sample
 - Piezometer seal
 - Observation well or piezometer tip
 - ▨ — Approximate extent of soft area

L⁺ 1195 + 38.84 BK -
DL⁺ 562 + 66.73 AH.
END OF PLAN
STA L⁺ 1196 + 30.53 BK =
DR⁺ 567 + 90.27 AH



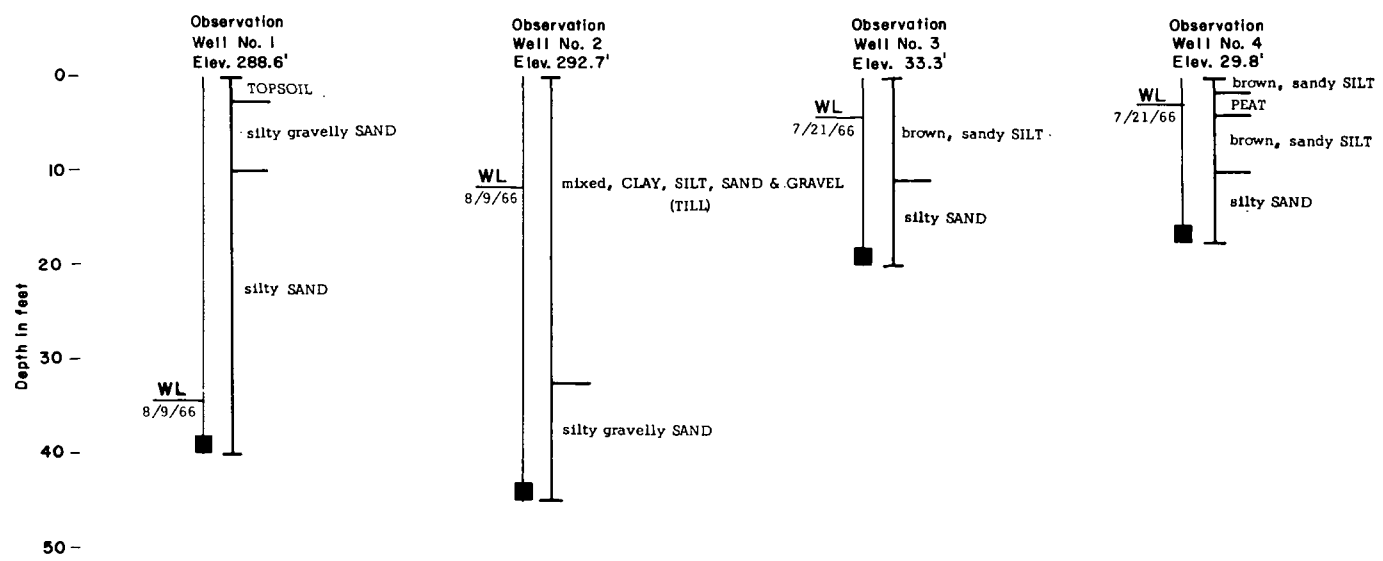
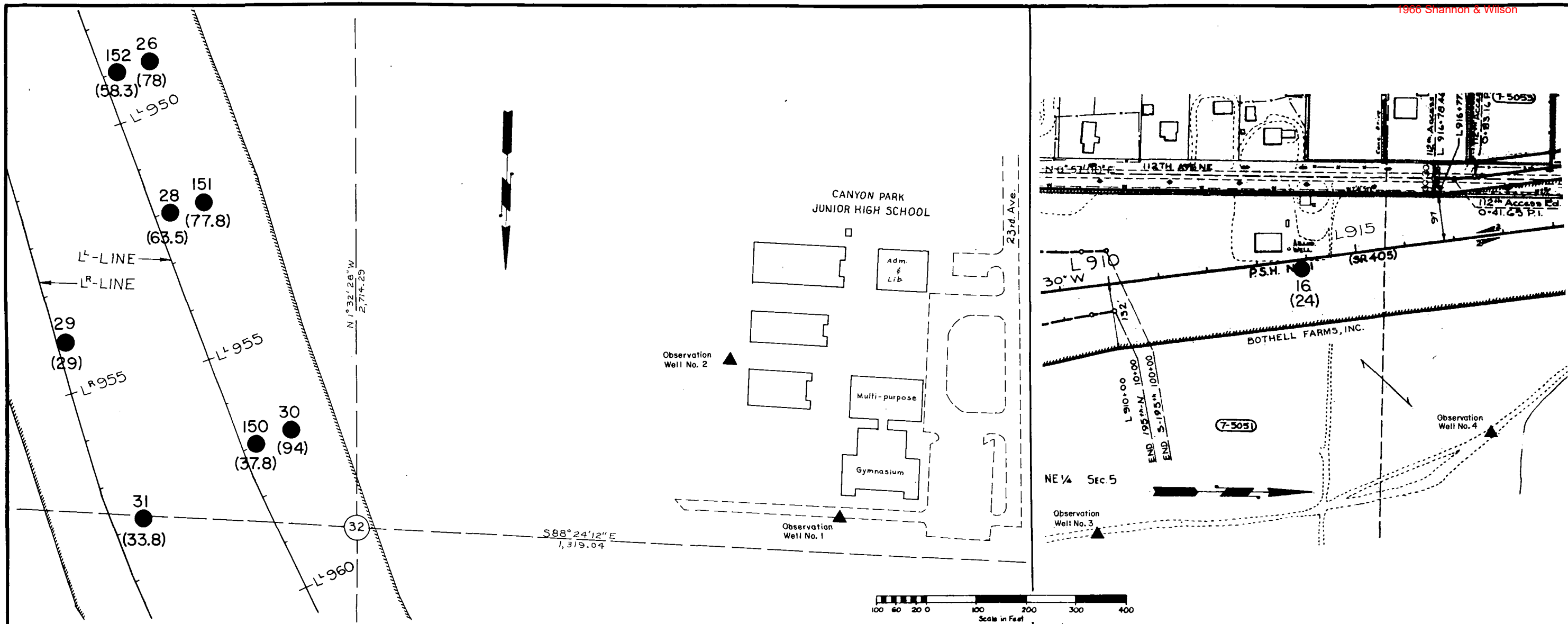
WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS
OLYMPIA, WASHINGTON

PSH I-RE (SR 405)
PLAN AND SOIL PROFILE
FB-LINE & FM-LINE

AUGUST 1, 1966 W-66-965

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SEATTLE, WASHINGTON

FIG. 30



NOTE:
Drawing based on plans supplied by Department of Highways.

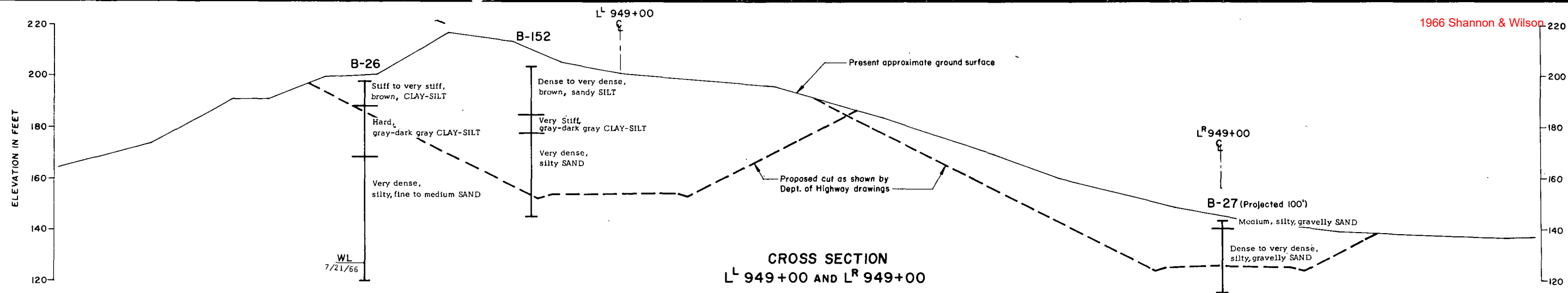
LEGEND:
 26 — Boring number
 ● — Boring location
 (78) — Depth in feet
 WL — Water level
 ■ — Observation Well tip

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 OLYMPIA, WASHINGTON

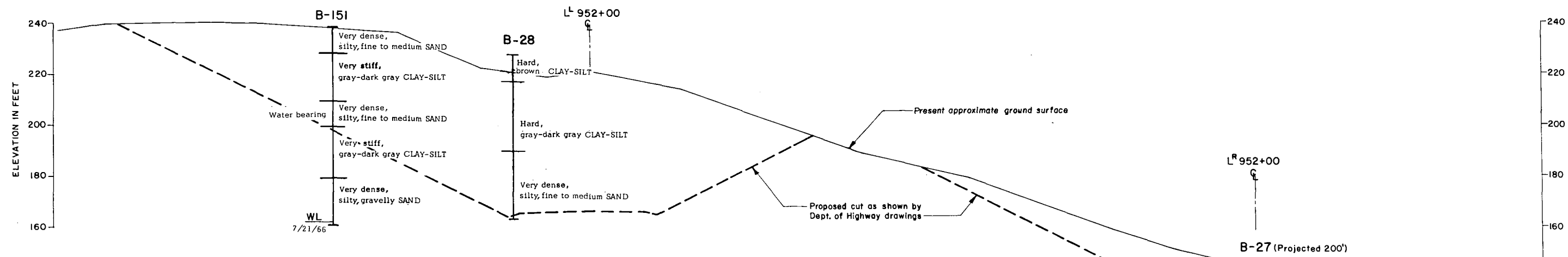
**PSH I-RE (SR 405)
 PLANS AND LOGS OF
 OBSERVATION WELLS**

AUGUST 1, 1966 W-66-965

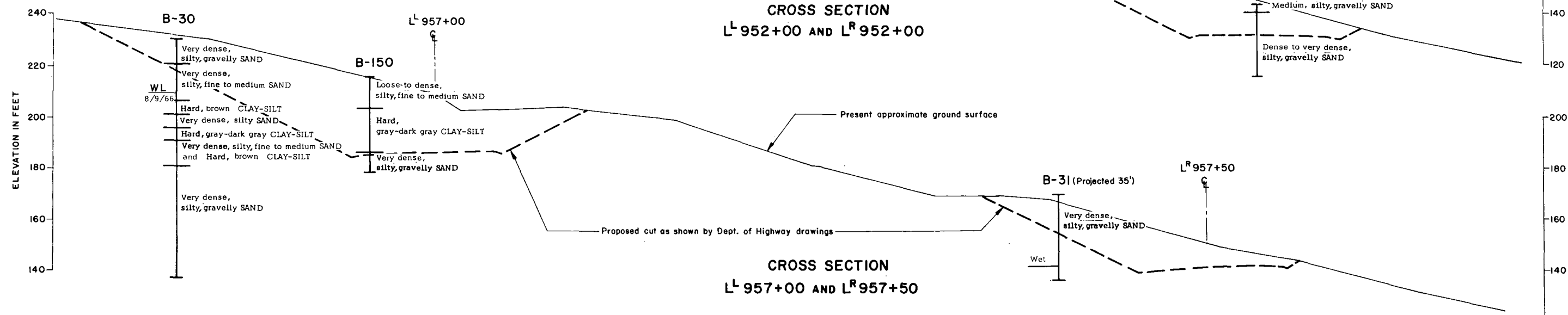
SHANNON & WILSON, INC.
 SOIL MECHANICS & FOUNDATION ENGINEERS
 SEATTLE, WASHINGTON **FIG. 31**



CROSS SECTION
L 949+00 AND L R 949+00



CROSS SECTION
L 952+00 AND L R 952+00



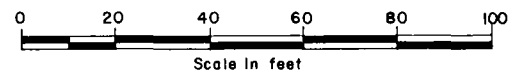
CROSS SECTION
L 957+00 AND L R 957+50

NOTE

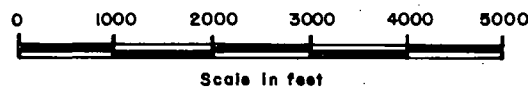
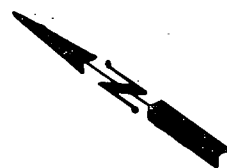
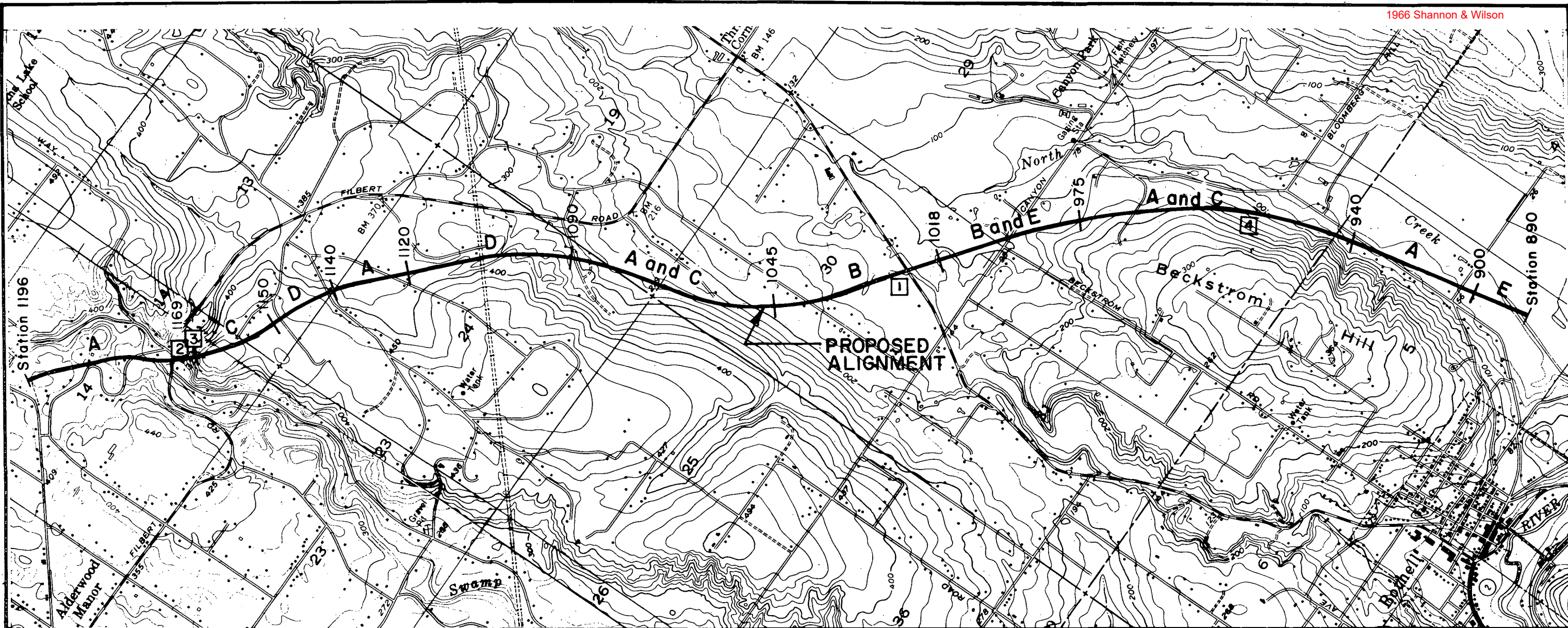
Drawing based on plans and profiles supplied by Department of Highways.

LEGEND

WL 8/9/66 Water level Date observed



WASHINGTON STATE HIGHWAY COMMISSION DEPARTMENT OF HIGHWAYS OLYMPIA, WASHINGTON	
PSH I-RE (SR 405) CROSS SECTIONS STATIONS L 949 TO L 957	
AUGUST 1, 1966	W-66-965
SHANNON & WILSON, INC. SOIL MECHANICS & FOUNDATION ENGINEERS SEATTLE, WASHINGTON	FIG. 32



Base map modified from USGS Edmonds & Bothell quadrangles.

Contour Interval 20 feet - Datum is Mean Sea Level

SOIL TYPES

- A - Silty SAND
- B - SAND
- C - Gravelly SAND
- D - Glacial TILL
- E - PEAT

NOTE

The soil types shown exist at grade in cut sections and approximately one-foot below the ground surface in fill sections.

LEGEND

I Location of bag sample for R value determination

WASHINGTON STATE HIGHWAY COMMISSION
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OLYMPIA, WASHINGTON

PSH I-RE (SR 405)
LIMITS OF SOIL TYPES

AUGUST 1, 1966

W-66-965

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SOIL MECHANICS & FOUNDATION ENGINEERS
SEATTLE, WASHINGTON

FIG. 33